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"The Marysville Buttes."

THE NORTHERN ELECTRIC RAILWAY

By Rudolph W. Van Norden
Member A. I. E. E., A. S. C. E.

After two or three days of travelling 'mid the everchanging landscapes of desert and mountain, the tourist on an overland train,—or possibly he may be a settler, looking for new fields to till in a land full of promise—looks out over the wide expanse of the great central valley of California with a sense of relief. His train is reeling off the last few miles before entering Sacramento, the Capital City.

As his gaze rests upon the seemingly limitless expanse of almost level country, he will, perhaps, ask somebody (and if it be a Californian he cannot resist telling of the beauties and possibilities of his country), what is it good for; can it be cultivated; what will it raise and a hundred other questions. Probably he will ask why all this land has not been settled on and cultivated long ago. The answer will be that it has, in spots, but that it is too big and there have not been enough people, or the facilities for transportation, to do it all at once.

If he is wise, he will stop over at Sacramento to seek further knowledge. Is this great country being built up, are the Californians doing it, or must I and those who follow me supply the necessary energy to start this great work? To the first query he is answered, Yes; to the second, he is told to look for himself, the way has been paved.

He is handed a time-table and his eye is attracted to the reminder below a copious list of trains, "a. stands for A. M., p. stands for P. M., and Northern Electric stands for development of the Sacramento valley." Now he knows the whole story and when he boards the spic and span electric train, whose very color breathes California romance in its reflection of the Golden Poppy, whose blossoms cover like a mantle the fields through which he is destined to pass, to be whisked by miles of fertile lands and to pass through towns where prosperity is evinced on every hand, he marvels at the work already done, the enormous possibilities for the future and then he feels like making a profound obeisance to the train, when he leaves it, for its share in making this development possible.

Description of the Country.

The Sacramento Valley has a length of about 200 miles and a width averaging 50 miles. The Sacramento river passes through its entire length from north to south and divides it about equally. The land adjoining the river on both sides is, as a rule, low and fairly flat and as it recedes from the river gradually rises and becomes more undulating until the foothills of the Sierra Nevada on the east and the more precipitous mountains of the Coast Range on the west are reached.

The one exception to this general condition is furnished by the "Marysville Buttes," a jagged group of volcanic peaks which appear to have been forced out of the depths of the earth in defiance with nature's plan of arrangement, into the very centre of the valley. These buttes can be seen from all points of the valley and are a picturesque contrast with the level expanse surrounding them.

The land throughout the valley has always been known to be fertile, but the bottom lands along the river are particularly so. Many sections on both the west and east sides have been under a high state of cultivation for years, but the bottom lands, due partly to the cost of reclamation works to prevent the overflow from the Sacramento river and also the lack of railroad facilities, have not had the opportunity for development that their value would seem to assure.

That the country with its relatively meagre population has much wealth is shown by the prosperous cities and towns scattered throughout the valley, the numerous and well equipped banks and the carefully appointed stores and business houses.

The cultivation of hops, wheat, sugar-beets, oranges, olives, the deciduous fruits and many other crops, of the finest quality and greatest quantity, wherever undertaken, aside from the possibilities for the recovery of gold in the rivers, pointed a reason for a rapid growth in population and wealth that might be expected with the advent of rapid and convenient transportation.

The great necessity was transportation. It was not expected that this would turn miles of uncultivated or overflowed land into a highly productive garden in a moment. But it was the late Mr. Henry Butters who believed in the country and the people and saw that the establishment of a modern railroad, affording swift means of transportation between the towns and through country having high potential values, would be the means of inducing a rapid but healthy growth and be the nucleus of a great system surrounded and fed by a great country.

It is no easy matter to inaugurate a new railroad through a more or less undeveloped territory. The financial start is often a hard thankless problem and the work which Mr. Butters and his associates had undertaken represented the faith and courage, characteristic of all the great enterprises in this, a comparatively new country.

The start was made at Chico and under the engineering direction of Mr. J. B. Robinson, a veteran railroad engineer, and Mr. J. Paulding Edwards, the electrical and mechanical engineer, to whose skill and ingenuity the system now owes its well designed and successfully operating equipment, a road 24.8 miles long was built to Oroville. These cities were growing and prosperous, the former in the midst of a fertile and well cultivated district, with growing industries of great promise, the terminus of a lumber railroad, a number of stage lines and the distributing point for a large mountain territory; the latter city, being in the foothills, likewise a stage line terminal and distributing point and the center of one of the greatest gold producing localities in the world.

There was no direct means of transportation between these cities, except by stage and the first section of this system seemed justified by these conditions.

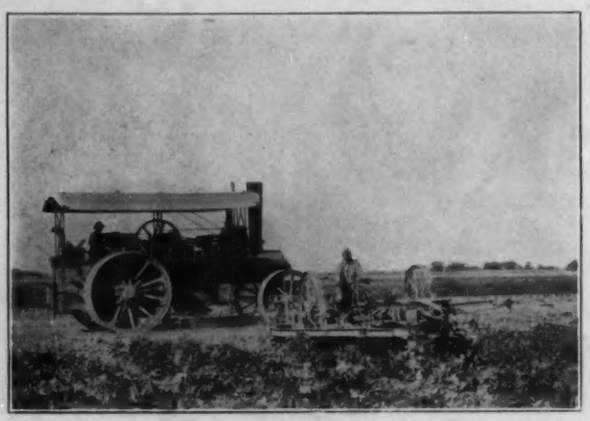
The first car from Chico to Oroville was run through on April 25, 1906. The success of this piece of railroad was an inspiration to spur on the work of further construction and on December 2, 1906, the line was completed to Marysville, an additional distance of 30 miles and regular operation was commenced.

There was in Marysville a primitive street railway system, its diminutive cars being hauled by mules. This was purchased, the road relaid with heavy rails and made standard gauge and extensions made to give a first-class local service throughout the city and between it and Yuba City, across the Feather river.

A local system was also purchased in Chico and in Oroville, a loop was built and a local service between that town and Thermolito was inaugurated. Thus these towns not only were provided with a means of rapid and frequent inter-communication, but were enabled to enjoy the benefits of urban transportation.

During 1907 construction was continued between Marysville and Sacramento and on September 1st of this year regular service was commenced.

Sacramento while literally not the head of navigation is practically so. There are several lines of steamers which tie up at this point; the possibility of making the road an outlet for a large freight transportation business, having steamer connection with the Bay Cities was apparent. Aside from a passenger terminal in the heart of the business section a branch to a freight terminal on the water front was built. This then gave a clear line of railroad reaching 122 miles up the Sacramento valley.

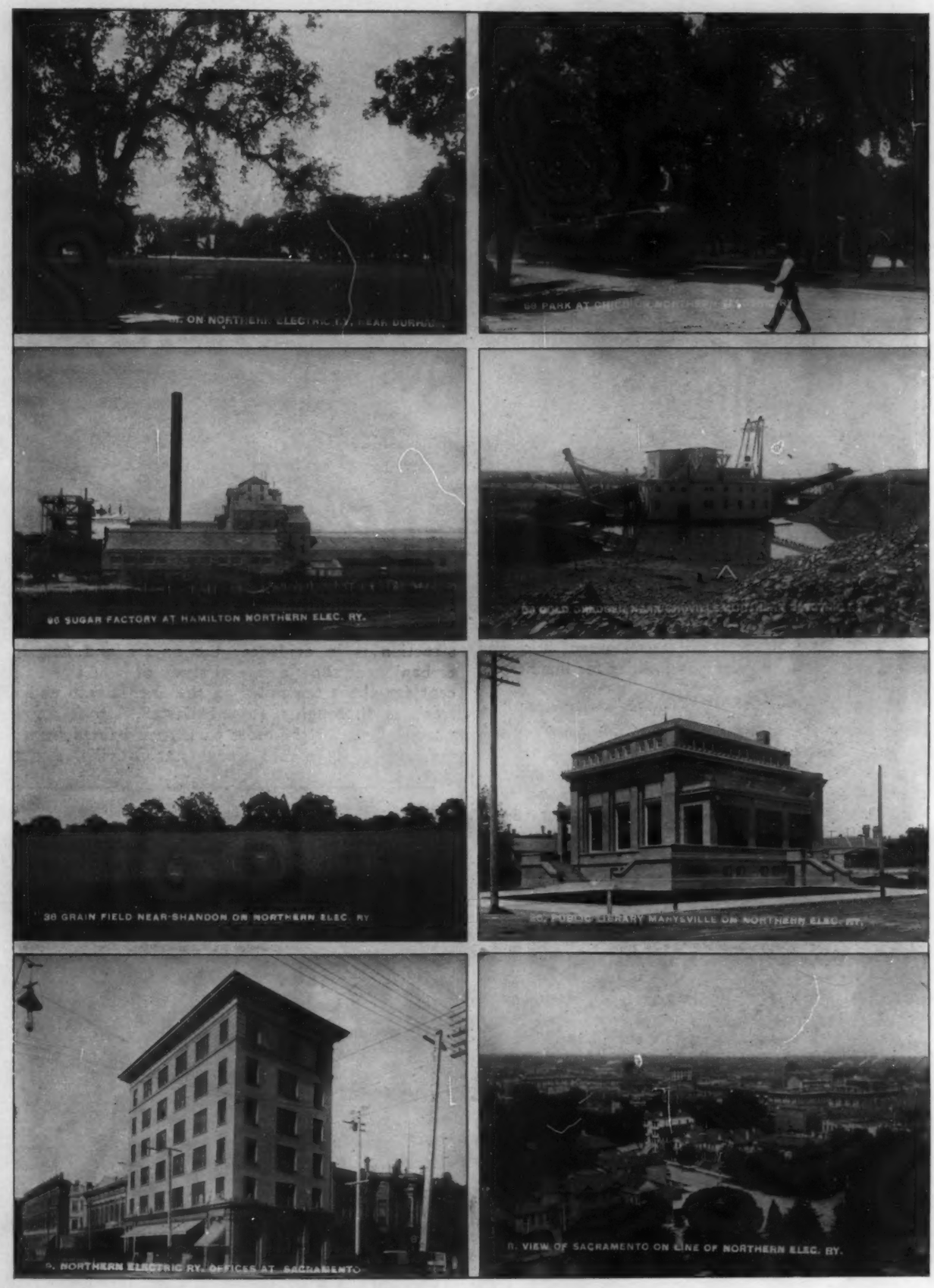


Plowing Sugar Beets Near Hamilton by Steam Power.

On the west of Chico and adjacent to the Sacramento river is a large section devoted to the cultivation of sugar-beets. There is at Hamilton a sugar factory. A line was therefore built from Chico, due west to the Sacramento river and after crossing the river, following the west side to Hamilton, a distance of 11 miles.

It is now proposed to continue the main line north from Chico, and following up the valley for 41.7 miles, to the city of Red Bluff. Surveys for this work have been made and much has been done toward the completion of this extension.

Another extension is in process of construction. This leaves the main line 4.4 miles north of Marysville and will extend due west to Meridian and after crossing the river, proceed northward to Colusa, a town on the Sacramento river. This branch will be 22 miles long and traverses a wonderfully fertile, but more or less undeveloped country. The land adjacent to this new line is mostly of sufficient height above the level of the overflow from the rivers to enable cultivation without the necessity of drainage. The soil here is from 18 to 25 feet in depth and has been pronounced


86 SUGAR FACTORY AT HAMILTON NORTHERN ELEC. RY.
38 GRAIN FIELD NEAR SHANDON ON NORTHERN ELEC. RY
PUBLIC LIBRARY MARYSVILLE ON NORTHERN ELEC. RY.
NORTHERN ELECTRIC RY. OFFICES AT SACRAMENTO
VIEW OF SACRAMENTO ON LINE OF NORTHERN ELEC. RY.

Views Along the Lines of the Northern Electric Railway.

On Main Line Between Marysville and Chico.

by the soil expert of the U. S. Government to be the premier of all California lands.

The absolute lack of transportation facilities is the only thing that prevented development here and illustrates one of the great possibilities for business of this system.

When that section between Marysville and Sacramento was commenced, the conditions were much the same; thousands of acres of the richest land were lying idle; today there are a half dozen towns laid out. Where three years ago there was not a person to be found for miles at a stretch, there are today scores of farms springing up and a rapidly increasing population. And the well filled, frequent trains are a tribute to the wisdom and sagacity of the founders.

General Description of Main Lines.

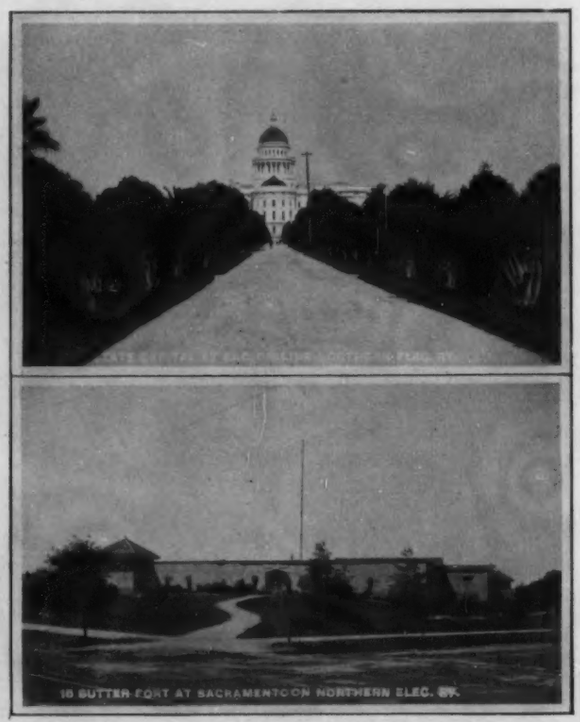
The Northern Electric has a total of 122 miles, not counting the local street railway systems which have a total of 17 miles of track; when the extensions, now under construction are complete, this will be increased to 193.5 miles.

The road between the present terminals, Chico on the north and Sacramento on the south, lies practically north and south in a generally straight line. That section of the road into Oroville is treated as a branch: it joins the through line at Tres Vias and runs east for a distance of 5.5 miles to Oroville. Except for that section where the foothills are approached nearing Tres Vias and the Oroville branch, the road is essentially level; the maximum grades at the points mentioned do not exceed 1 per cent.

The rail equipment throughout is of 60 lb., A. S. C. E. standard profile.

Sawn cross ties from the hearts of pine and fir timber were laid throughout the system, this timber being of good quality and supplied by the Diamond Match Company from their forests in the nearby Sierra Nevada mountains.

Throughout the system a high class of track construction is in evidence; the nature and height of embankment show a careful study of conditions. Except for about ten miles on the Sacramento end, the track is thoroughly stone-ballasted. Rock for this purpose has, for the most part, been hauled from the tailing pits of the gold dredgers at Oroville. A crush-



Views in Sacramento.

Hauling Rock for Ballast from Dredger Pits at Oroville.

ing plant at this point consisting of a No. 5 Gates crusher, electrically driven, with the necessary equipment, was provided for this purpose. This rock is all in the form of boulders and cobbles and much of it very hard. There is, of course, a large percentage that does not require crushing.

From Chico to Yuba City the road passes through a number of towns—Durham, Live Oak, Gridley, Biggs and several prospective colonies which are rapidly becoming populated. There are few curves and those are of long radius, while there are long tangents, the longest being fifteen miles.

Particular attention has been given to the design and construction of culverts, cattle-guards and fences. The first, while of little use during a large part of the year, become very important factors during the rainy season, disposing of the sometimes rapid run-off gathered from the broad flat lands adjacent to the road.

The country is being cut up into small farms and holdings which are becoming more numerous every year. These necessitate many crossings, some public, some private, and therefore the greatest care must be exercised to prevent animals being driven or wandering over these crossings from getting on to the right of way and coming in contact with the third rail. A number of standard designs have been adopted for installation where the height of embankment varies.

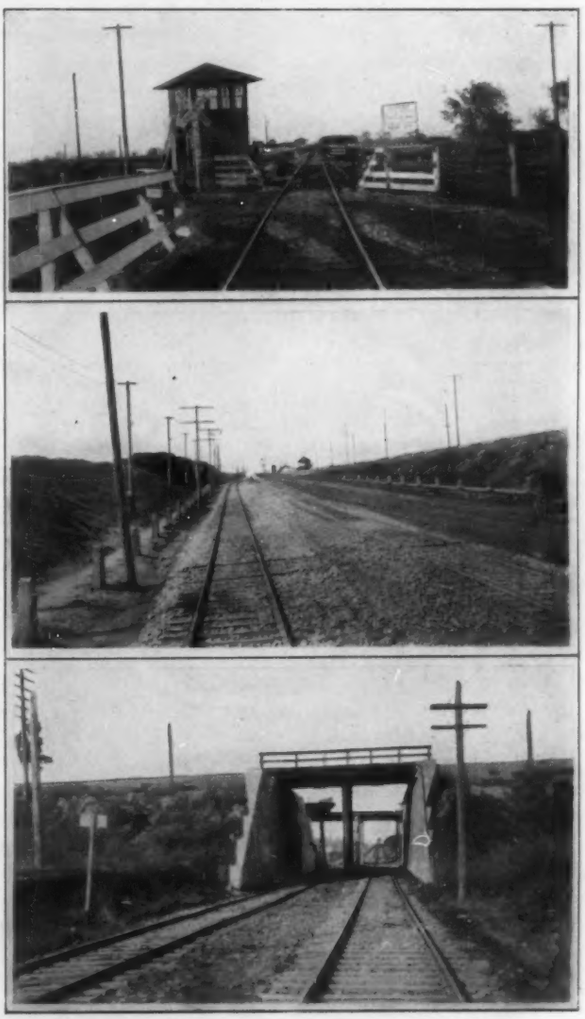
It is, of course, necessary to have fences on either side of the right of way, which are not only sufficient to keep out cattle and other domestic animals, but even dogs and rabbits.

The right of way is from 80 ft. to 100 ft. in width.

Being a single track system, it is necessary to pay great attention to meeting points in the running of trains. There are sidings at all the principal stations, but additional sidings at the proper points have been provided for this purpose. At these sidings there is a box mounted on a post; this contains a telephone connected to the private wires of this road. A train conductor can, by this means, get into communication with the Dispatcher and may readily ascertain the position of any and all trains he has orders to meet.

At Live Oak the road crosses the line of the Southern Pacific at grade. There has been placed here an interlocking switch tower at which an attendant is constantly on duty. This tower was built and is maintained jointly by both railroads.

From Yuba City the road crosses the Feather River on a steel truss bridge into the city of Marysville. This bridge is owned jointly by the railroad and the counties of Yuba and Sutter, and supports a roadway, as well as the track. A very difficult and interesting problem was encountered during its construction. It

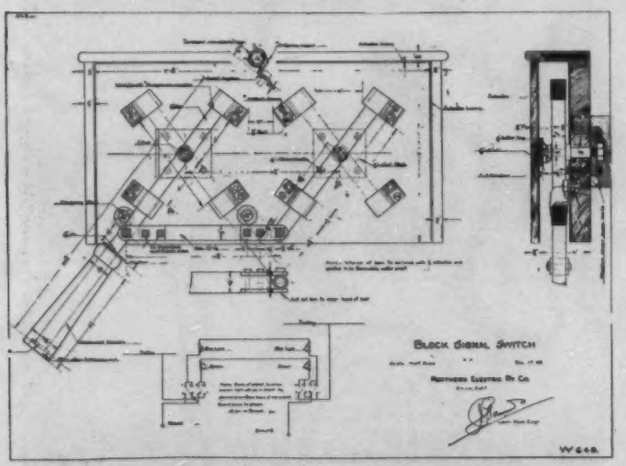


1. Interlocking Tower at Live Oak.
2. Approach Into Marysville Between Wing Levees.
3. Subway Through Levee at Sacramento.

was built to replace an old wooden structure and while the work was in progress, both the railroad and the wagon road were at all times in use.

Steel Bridge Over the Feather River at Marysville.

There is a single track over this bridge and so, to prevent the possibility of an interurban train and a local street car from meeting on the bridge, a simple block system has been installed. It consists of a box at the commencement of the embankments at either end of the bridge, in which is a switch. The throwing of these switches cause a danger signal to show at the opposite end from the switch thrown. A diagram of this switch is herewith reproduced.



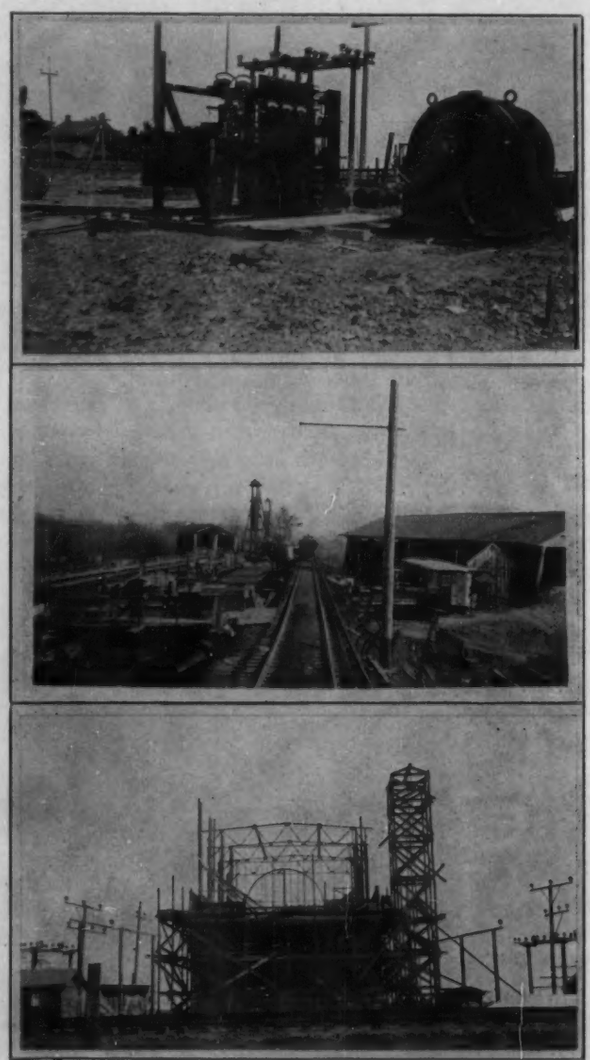
Marysville lies between the Feather and the Yuba rivers, the latter joining the former at this point, forming a right angle. The city is at times below the water level of the rivers, and is thus surrounded by levees. In order to give a proper grade from the bridge to the streets of the city, it was necessary to cut the levee. This was accomplished by building wing-levees and the resulting roadway has been made into a sort of boulevard.

After passing through the principal streets of Marysville the road turns south and crosses the Yuba River, this time on a timber pile trestle. The United States Government is at present undertaking the work of altering the course of the Yuba River so that it will eventually join the Feather River at a point south of the present junction. In anticipation of this change the trestle was not constructed as a permanent structure, but at the point where the track will cross the new channel there have been placed nineteen 40-ft. steel spans supported on permanent concrete piers.

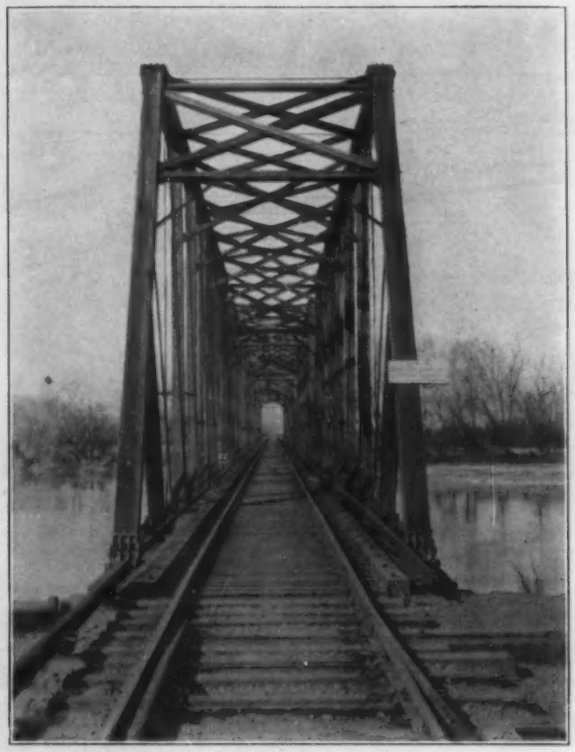
Following the crossing of the Yuba River the road enters a low flat country which, while not actually subject to overflow from the Sacramento River, has as yet not been thoroughly diked, and is subject to overflow, during periods of very high water, from the Yuba and Bear rivers. This fact and the sometimes quite heavy current of the overflow necessitated a class of roadbed construction which would at once resist any current pressure to which it might be subject and at the same time turn the currents into proper channels through culverts and other openings. This has been accomplished by first building substantial pile trestle and then filling it out with an embankment consisting of the tailing cobbles and gravel from the dredger mines at Oroville. This material will remain in place under the most adverse conditions of flood and current.

Dikes and levees are now nuder construction for the reclamation of this district.

The last thirty miles of the road before reaching Sacramento is in a flat but well-drained country, and is not subject to the possibility of overflow. There are throughout this section a number of well laid-out town-sites and from the frequent sales of real estate.



1. Temporary Sub-Station.
2. Replacing Wooden Bridge Across the Feather River at Marysville with a Steel Bridge.
3. Sub-Station No. 8 at Nicolaus under Construction.



Bridge Over the American River Near Sacramento.

in small holdings, give every evidence of a very rapidly growing population.

The road enters Sacramento after crossing the American River. This it does on a composite Howe truss bridge. In entering Sacramento very much the same condition is encountered as that at Marysville. It is necessary to go through a levee. Wing-levees are built to allow of this entrance. At the lowest point of the cut, at the center of the levee, it has been found that water would seep through from the river and collect in the cut. Provision to obviate this has been made by installing a small motor-operated pumping rig. The cut is heavily constructed with concrete piers and wing walls and supports several railroad tracks, laid lengthwise of the levee.

Within the city the road has a double track and passes through a number of streets until the passenger terminal at Eighth and J streets is reached. There is a "Y" provided here to enable the turning around of cars or trains.

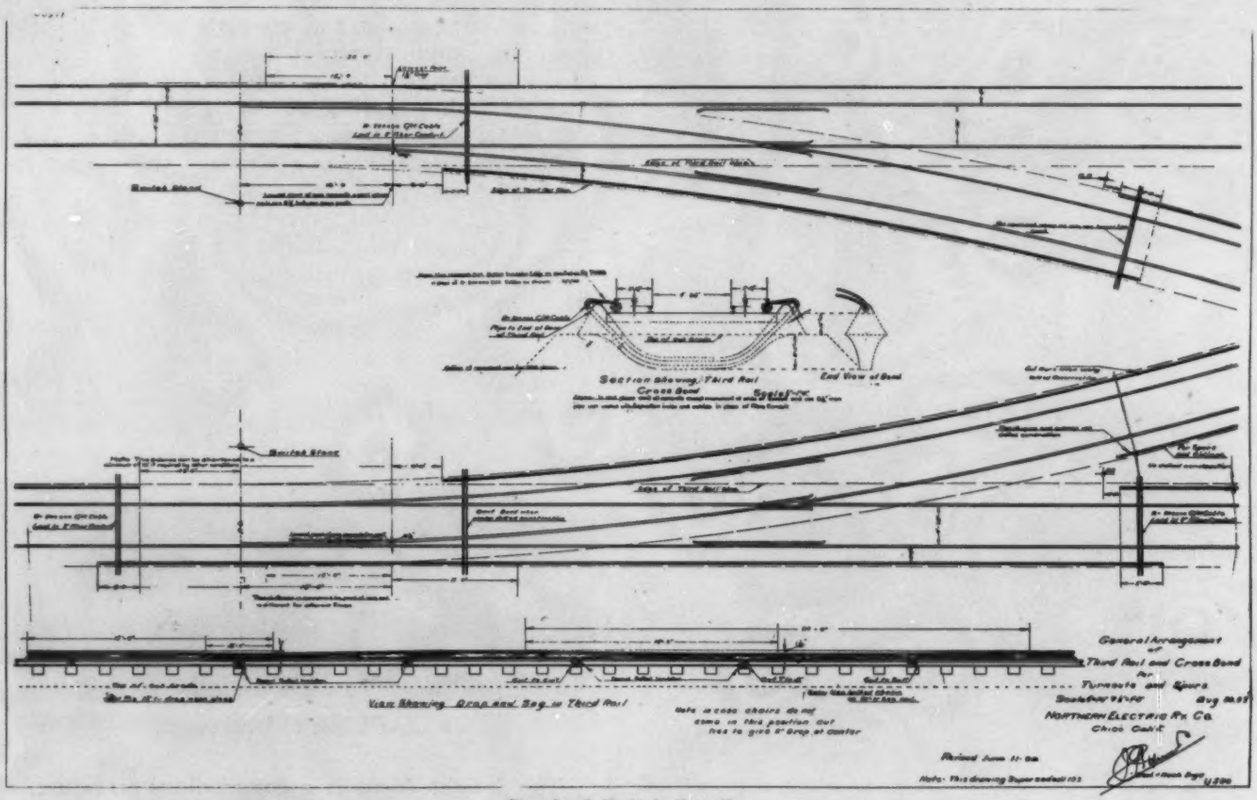
Soon after entering the city, a branch line has been constructed to a freight terminal at the city wharf on the Sacramento River. This line practically circles the city, as it was not possible to secure a franchise to operate freight trains through the streets. This branch is 5.7 miles long and its construction throughout is equal in quality to the high standard maintained by the system.

Freight Depot at Sacramento.

The freight depot is a commodious structure, of sufficient size to handle the cars and business for some time to come; it takes up a large part of a block east of the wharves. The tracks are so arranged that cars may be shunted directly on the wharf and loaded to or from the steamer.

The question of the method of supplying electricity to operate trains was one which received a great deal of thought and consideration. For long distance interurban work, both the various forms of trolley construction and the third rail have their advocates. The engineers in charge of this work were strongly in favor of the latter course and it was adopted. The subsequent result seems to point to their wisdom.

The Wharf at Sacramento; Steamer "Pride of the River" on Right.



Standard Switch Details.

Through cities and towns a plain trolley construction is used; the cars are therefore equipped both with the trolley and the third-rail shoe. In changing from the former to the latter and vice-versa, the trolley is raised and lowered in the ordinary manner. An ingenious device, controlled by interlocking automatic relays, cuts out electrical connection to the shoe when the trolley is in use. This is described elsewhere, together with the car control system.

Standard forms are used for switches and crossovers, passing tracks, etc.; this is important, as the position of the various arrangements for the third-rail must be accurate.

An ingenious but very simple device is used on switches to electrically disconnect the third rail when the switch is not in use. It consists of a break in the rail, in which is inserted an insulating wood block. Fastened to the rail at either end of the break and extending sideways in a horizontal direction are two hook-shaped receptacles. An iron rod, with a wood handle at one end, which acts as an insulator, is laid on these projections in such a way that it fits into the curve or hook of each. This closes the circuit. When the track is not in use, the bar is simply pulled out.

Third Rail Disconnecting Switch.

The third, or electric rail, is 60-lb. steel, having the A. S. C. E. standard profile. It is mounted on a special insulator, designed by the engineer of the road. This consists of a treated maple block, fitted to a malleable cast-iron base and supporting a cast-iron flaring top, to which the rail is fastened. The insulators are placed on every fifth tie, which is 18 inches longer than the others, for this purpose,

The loss by current leakage from the third rail is remarkably small, being one-half ampere per mile, under the most severe conditions of weather.

The track rails are bonded with two No. 0000 and the electric rail with two 400,000 cir. mil. Chase-Shawmut soldered bonds.

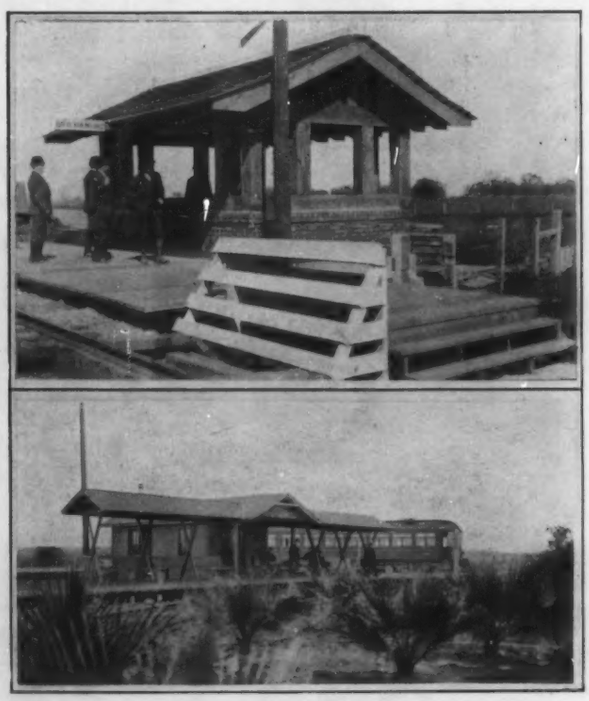
At road crossings, where there would naturally be an interruption in the electric rail, a heavily insulated cable was laid beneath the crossing; this was found to give trouble and resulted in changing a number of these underground cables to an overhead construction, two poles being used for the purpose. This conductor is made of two 500,000 cir. mil. copper cables.

Stations.

A number of types of passenger stations have been adopted. A new depot at Thermolito built largely out of cobbles is of a very neat and artistic design. The illustrations give a good idea of this progressive type of building.

Method of Carrying Third Rail Conductor Over a County Road.

There are a number of points along the road which, while an attendant is unnecessary, afford considerable passenger business. These are simply shelter stations and are constructed on a standard design. They are equipped with a manually operated semaphore, which when in a horizontal position, lights a series of 5 lamps for night use. The cost with a 100 ft. platform is about $450.



1. Shelter Station. 2. Station at Tres Vias.

Car-Houses, Repair Departments, Etc.

Located at Mulberry, a suburb of Chico, are the main car-houses, the repair-shop, the car-building shop and the administration offices. Here is also a sub-station and the office of the Chief Train Dispatcher.

The car-houses are conveniently placed, facing the county road, on which the main line operates. The building is a concrete and timber structure, 140 ft. by 140 ft., covered with corrugated iron, and contains eight tracks, all of which connect with the main line. Within the building there are pits throughout the length of the two tracks adjacent to the machine shop,

Depot at Thermolito and Its Artistic Interior.

so that temporary or permanent repairs may be made at any time to the working parts of coaches or locomotives. Doors at the rear of four of the tracks allow the passage of cars through to the car-shop, which is located directly in the rear of and a short distance from the car-barn.

On the right, as one enters, incorporated as part of the car-house building, is the sub-station, described elsewhere. Behind this is a machine shop, equipped with all the machines necessary for car-repair work. Next to these shops is the air-brake department, with equipment for repairing and testing of this apparatus. In the rear and adjacent to these shops is a forge-shop. This has six forges and one 300-lb. hammer.

To the left and at the rear of the car-house is the armature and electric repair department. Armature repairing is perhaps the most important of the various classes of repair work on an electric railway system. The repairing and rewinding of railway armatures has become almost an exact science and the work is thoroughly and expeditiously handled here. A little device, designed in this shop, for slotting commutators

is of interest. After the commutator has been turned and finished, this slotting device, consisting of a steel circular saw, mounted on a mandrel and driven by a motor, is run between each commutator bar. The armature is mounted in such a manner that its axis is perpendicular to that of the mandrel and is turned automatically, after each slotting operation. This act of slotting removes the "burr" and a small portion of the insulation at the edge of the commutator bar, leaving the bar clean cut and every slot the same width; it increases the life of the commutator and the brushes and prevents "flashing over."

Passing from the car-house to the car-shop, one finds a well-constructed corrugated iron building, equipped for the erecting and finishing of cars. A wood-shop with machinery to turn out all the work from the heavy frames to the inlaid hard-wood finish is at one end; at the other is the paint shop.

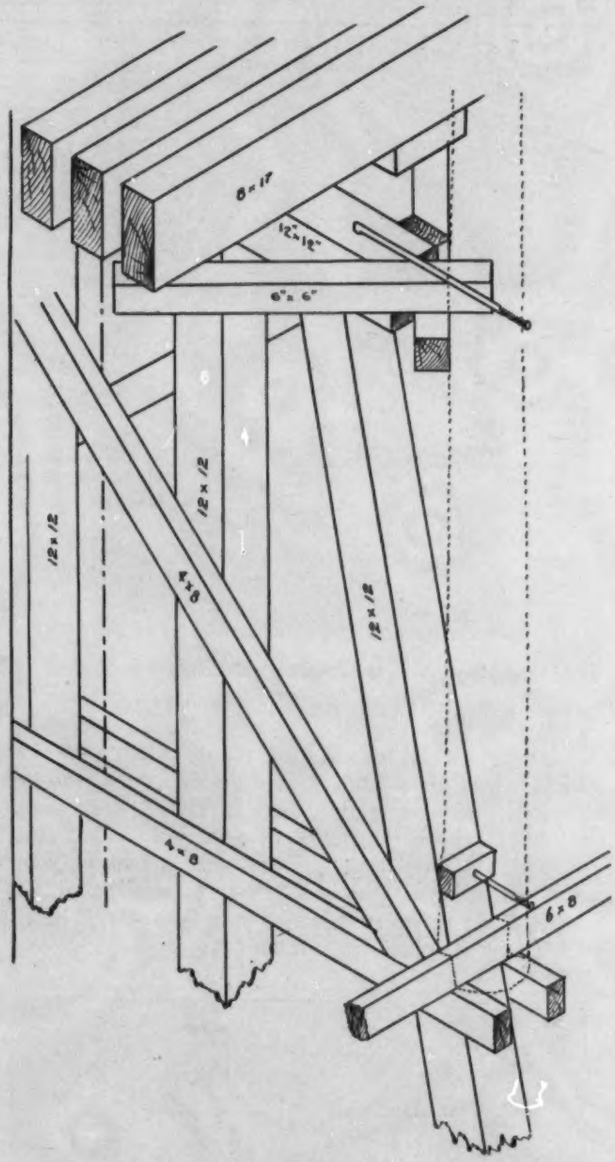
Many of the later cars of this company have been built in this shop and a minute examination evinces the care and thoroughness exhibited in their construction and a finish which it would be impossible to get on cars purchased in the open market.

One of the latest examples of the product of this shop is car No. 130. This is a combination passenger and baggage type; it has a length of 50 ft. over all and the weight equipped is 83,400 lbs. The interior finish is Honduras mahogany, the panelling being inlaid with white holly and ebony in a neat marquetry design. The ceiling finish is full "Empire." The seats were furnished by Hale & Kilburn and are covered with a figured blue plush. There are toilet facilities at both ends and in general the car is the embodiment of the most modern design for comfort and ease.

The motor equipment consists of four 90-h.p. Westinghouse No. 121-A motors mounted on Baldwin No. 200 single trucks with 36 in. standard rolled steel wheels.

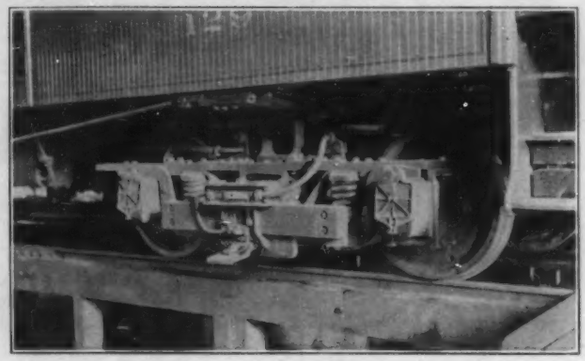
The air-brake system is Westinghouse automatic, schedule AMM, with quick release and recharging feature. Air is supplied for the air-brake system by a Westinghouse D-3 air-compressor set, slung from underneath the car-body in the usual manner. The draft-gear is of the "radial" type, described elsewhere, and the control is by the electro-pneumatic system, which has been adopted on all of the cars of this company.

The third-rail shoe, or current collector, is of cast-steel; it has a hinged mounting and is fastened to the



Standard Connection Between Pole and Trestle Bent.

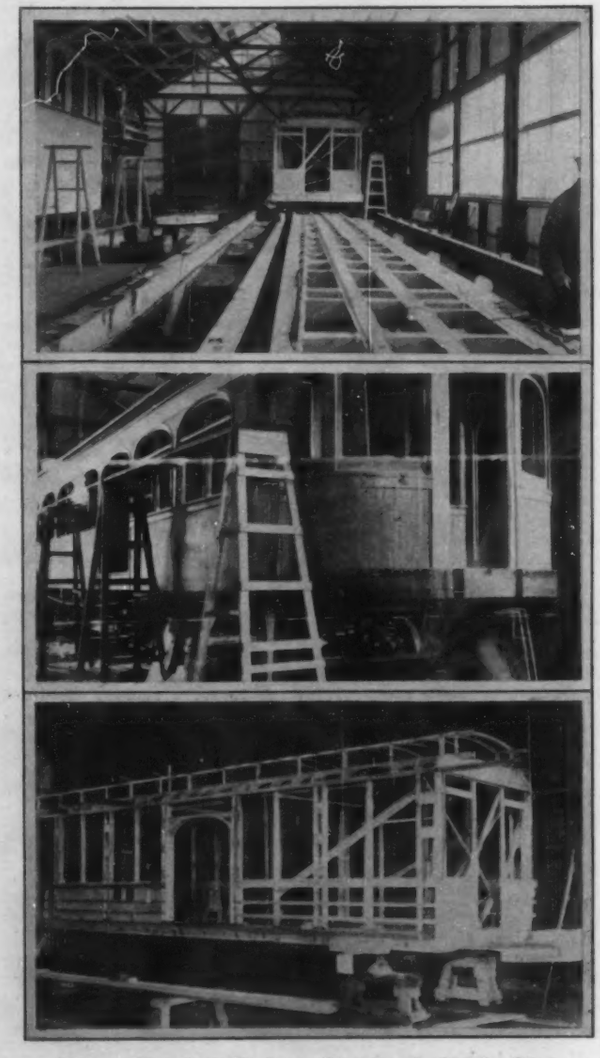
The Car-Houses at Mulberry.



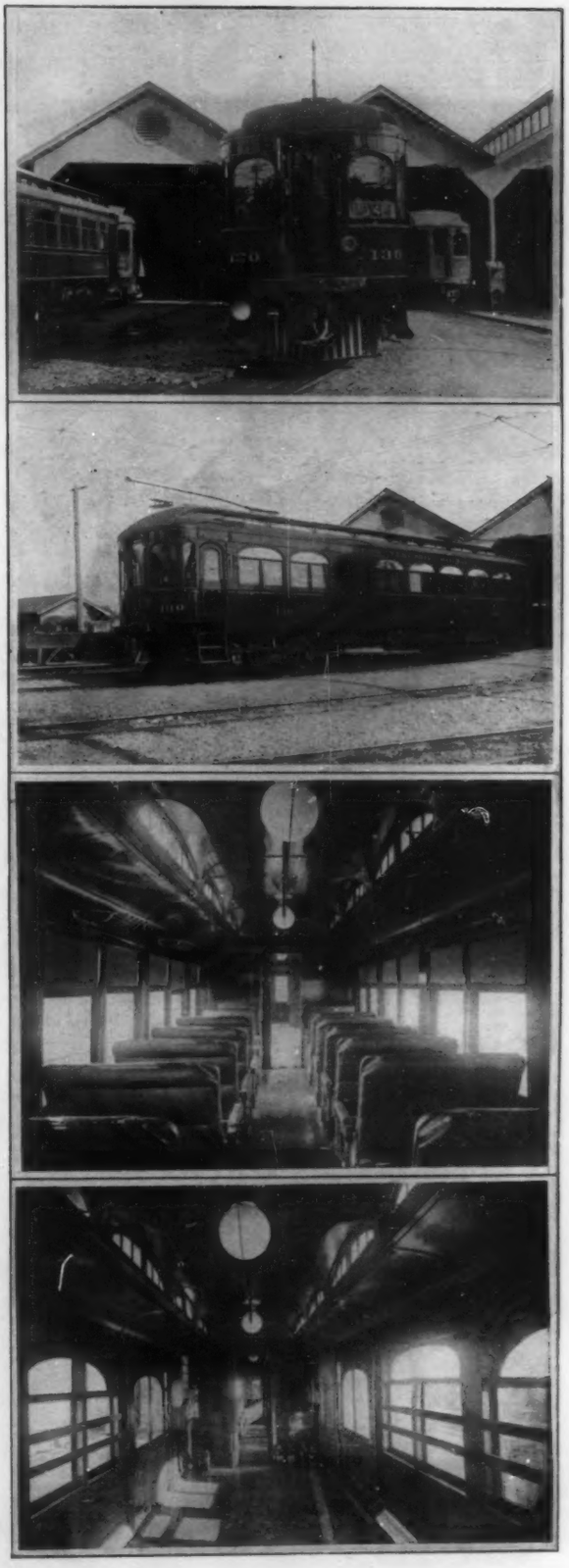
Third Rail Shoe in Use by the Northern Electric Railway.

truck in a simple and effective manner. This arrangement is another of the many features designed for this system by its engineering department.

A fuse is carried above the shoe, where it is readily accessible. This fuse is made from sheet copper and is a strip of the proper width to be effective; at its middle point a hole is drilled. When the fuse is ruptured it naturally breaks through the hole as the greatest current density is at that point. The inductive effect caused by the breaking of the fuse has a tendency to separate the broken ends, thus preventing the arcing over of the current.



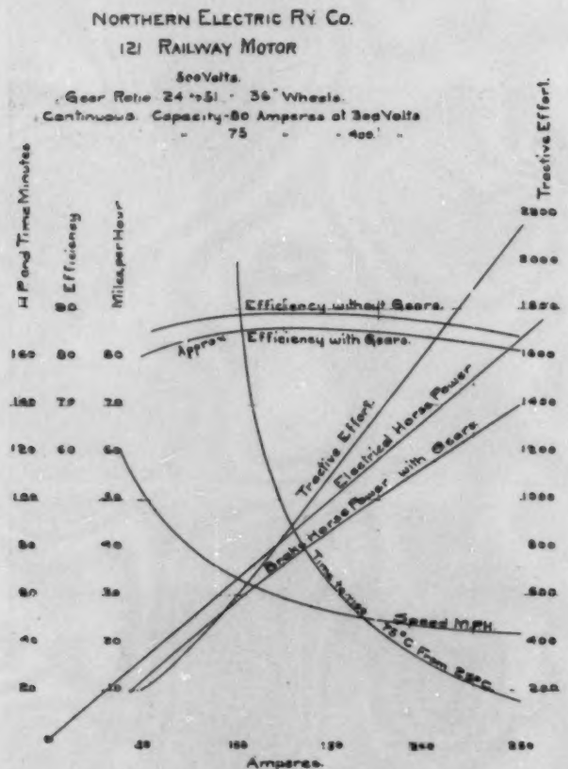
Views Showing Various Stages of Coach Construction at the Mulberry Shops.



Exterior and Interior Views of the Car No. 130.

LIST OF ROLLING STOCK AND EQUIPMENT

Type of Car.	No.	Weight.	Length.	Motor Equipment.	Trucks.	Brakes.	Shop.	Gear.
Combination (baggage, smoker, pas.)	2	85,860	56 ft.	Quad. West. 121	Bald. 200 36" wheels	West. aut.	Reb.	24/51
" "	3	80,000	"	"	"	"	"	"
" (passenger and baggage)	6	83,400	"	"	"	"	Built	"
" (mail and baggage)	3	40,000	55 ft.	.....	St. Louis 34" wheel	"	Reb.	.....
Passenger coaches	3	55,000	52 ft.	.....	"	"	.....	.....
" "	3	78,400	56 ft.	"	Bald. 200	"	.....	"
" "	1	76,000	52 ft.	"	"	"	.....	"
" trailers	10	61,250	56 ft.	.....	.....	"	.....	.....
Combination (open and closed)	2	49,500	39 ft.	Quad. West 93-A	"	West St.	.....	22/65
" "	3	36,000	39 ft.	Doub. GE-202	St. Louis	"	.....	15/71
Open 14-bench cars	2	30,000	40 ft.	Doub. GE-67	"	Hand	.....	19/65
Single truck, city cars	4	17,000	28 ft.	Doub. GE-800	Brill, 21E	"	.....	14/67
Locomotive (steel)	1	64,600	31 ft.	Quad. West. 121	Bald. 200	West. St. & aut.	Built	16/59
" (Cons. type)	3	79,500	40 ft.	"	"	"	"	"
" "	1	37,600	36 ft.	Quad. GE-67	St. Louis 47	"	"	16/65
" (steam)	3	120,000gr.	.....	16 x 24 cyl.		West.		
Flat cars	161	27,000	40 ft.	40 tons cap.				
Rodgers ballast cars	50	36,500	37 ft.	"				
Box cars	99	37,200	38 ft.	"				
"	26	22,800	28 ft.	20 tons cap.				
Flat cars	1	22,800	37 ft.	"				
"	22	16,300	31 ft.	15 tons cap.				
Wrecking car	1	.....	.....	2 15-ton cranes.				
Line tower car	1							
Water car	1							
Steam pile driver	1	.....	.....	30-h.p. engines, 3600-lb. hammer.				
Rodgers ballast plow	1							


NORTHERN ELECTRIC RY CO.
121 RAILWAY MOTOR
Gear Ratio 24 to 51 - 36" Wheels.
Continuous Capacity-80 Amperes at 500 Volts
" 75 " 600 "
H P and Time Minutes
Efficiency
Miles per Hour
Tractive Effort.
Efficiency without Gears.
Approx. Efficiency with Gears.
Tractive Effort.
Electrical Horse Power with Gears.
Brake Horse Power with Gears.
Time in Secs. for 1 Sec. Speed M.P.H.
Amperes.

Characteristic Curves of No. 121 Railway Motor.

Lighting is accomplished by five enclosed arc-lamps in the ceiling and there is also an arc headlight.

A maximum maintained speed of 52 miles per hour is possible and is about that to which all of the interurban cars are geared.

The freight locomotives are a development of this company; that is, each one has been built with the special conditions of operation in view and some novel features have been incorporated.

The first one put in use was a combination of the various parts which could be quickly procured. It was an ordinary flat-car, four second-hand street-railway motors, a controller from another source, and some lumber to build a cab. This primitive freighter has had a good record for work and is even now in use for switching purposes.

Designs for passenger coaches and freight locomotives, having steel framework and covering, have been made; none of the former have as yet been constructed, but one of the latter has been built and is proving itself to be highly satisfactory.

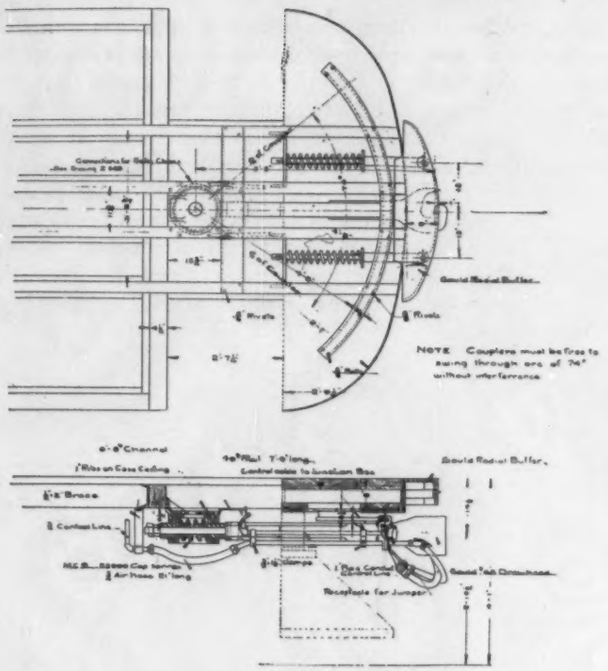
COST OF CAR NO. 130.

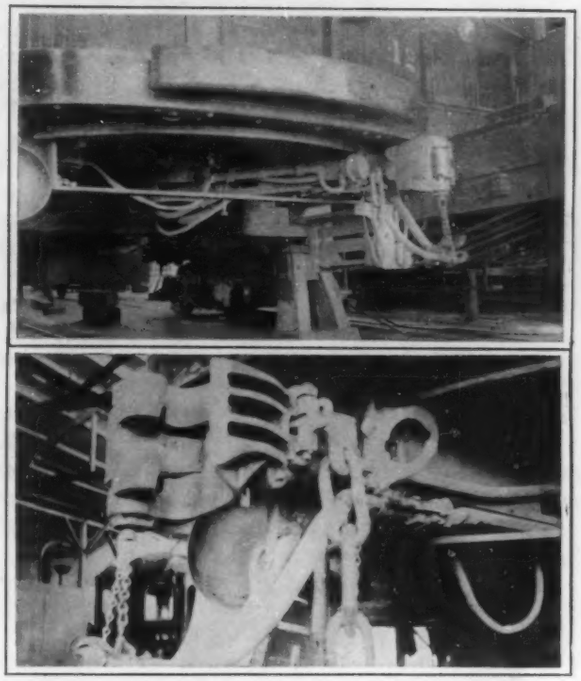
Class of Work.	Labor.	Material.
Body	$ 817.25	$1,126.04
Complete body	2,269.91	1,304.94
Paint	424.72	122.53
Electrical equipment	369.27	1,871.58
A. B. equipment	152.92	690.03
Radial draft gear	61.84	10.57
	$4,095.91	$5,125.69

Total shown	$ 9,221.60
Trucks not included	1,486.00
Motors not charged out	2,848.00
Cost complete	$13,555.60

The freight locomotives have the same motor equipment as the passenger cars, but are geared to a speed of 25 miles per hour.

There is a device installed, operating in conjunction with the multiple-control which consists of a switch that throws all four motors in series; this is for starting heavy loads. When the train is once started, this switch may be thrown back again, thus restoring the regular connections between the controller and the motors.





Views of Radial Draft-Gear.

The Westinghouse Electro-Pneumatic System of Car Control.

It has been already stated that this system has been adopted for the control of all interurban cars and trains. While it is a standard system, its working is not universally understood and a description in detail will be of interest to many.

At the request of the writer, this system as used by the Northern Electric Company is described by Mr. Edwards as follows:

General Description.

The system is designed for the operation of motor coaches for train service, consisting of a solid train of motor coaches, or a train of motor coaches with intermediate trailers, or for the operation of motor coaches, as single units. The motors throughout the train are operated simultaneously, each taking a proportionate share of the load and the control of these is affected at a single point at the head of the train.

The system is electro-pneumatic and utilizes compressed air from the air-brake system for the operation of the main switches in the motor circuit. Electro-pneumatic valves govern the admission of air to the operating devices; the operating coils being in a separate low-voltage circuit entirely independent from the motor circuit. This low-voltage circuit is the only one which it is necessary to establish from car to car, and is also the only one brought above the floor of the car. There are thus two circuits electrically independent, viz:

(1) The operating circuit, carried throughout the train and energized by a small storage battery.

(2) The motor circuit, confined entirely to each motor car, including the motors and switches for connecting these in series, and parallel, with the various resistance steps.

The apparatus for handling all main currents is located beneath the body of the car.

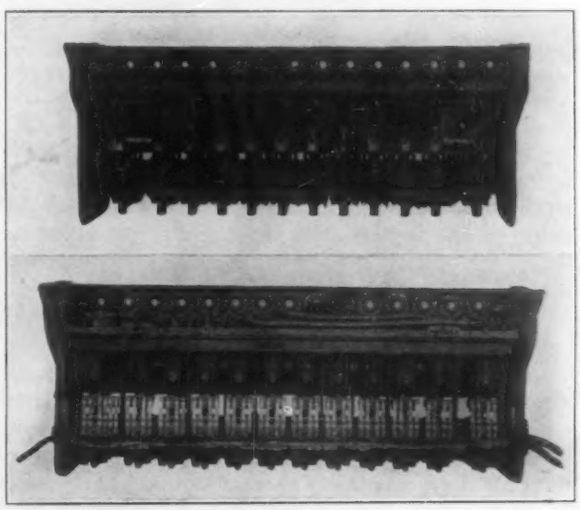
The Switch Group.

Fig. 1 is a front view of the switch group with the covers removed, showing clearly the contacts and arc chutes, and electro-pneumatic valves.

Fig. 2 is a rear view showing interlock fingers and contacts.

These switch groups consist of twelve independent unit switches grouped together in a line and mounted on a frame forming a small capacity air reservoir. Between the switches are arranged blow-out coils. These blow-out coils are either connected together in series in the main circuit, or in single switch circuits, as may be the case; dependent on the various switch movements.

The switches and blow-out coils are surrounded by incombustible vulcabeston boxes, the switch box being lined with asbestos and soapstone arc shields. The switch arm is hinged upon a support and carries



Figs. 1 and 2.

a contact proper, which has an independent movement affected by a spring acting between contact and arm. The operation of this spring secures the initial contact at the point of removable contact tips, and the final or resting position further along the surface, giving a wiping and rocking motion of the fingers, maintaining a positive contact upon which deterioration is a minimum. The piston of each cylinder is connected through an insulated joint to the switch arm. On the piston rod there is an arm holding an interlock segment, securing simultaneous movement of interlock and piston. The air cylinders are bolted to the cylinder head, which also forms a shell for valve magnet, this casting having a channel connected with the air chamber to which it is bolted. The switches are bolted to a substantial base plate bolted to the air chamber frame, the switch bolts forming terminals for motor leads and inter-connections between switches, all connections being thoroughly insulated by vulcabeston sleeves and washers.

A section of the individual switch units is shown by Fig. 3.

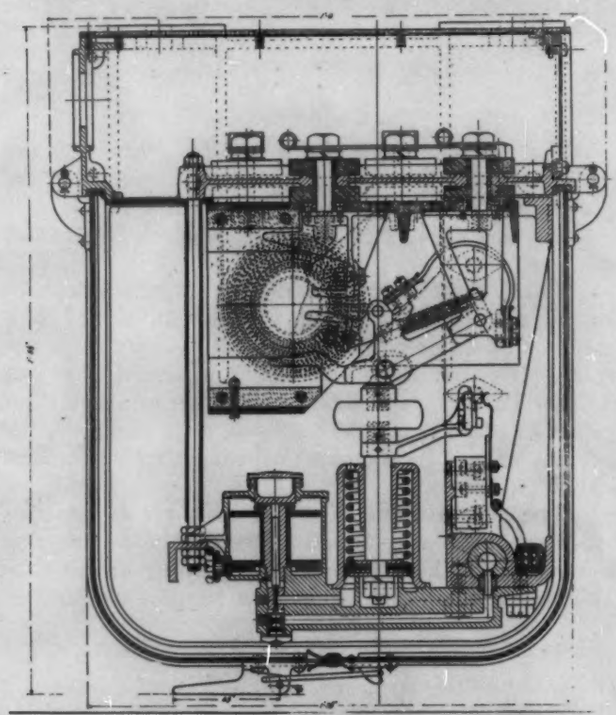


Fig. 3.

The interlocking switches consist of spring contact fingers sliding on segments and are electrically connected with the magnet valve in such manner that the closing of one switch energizes the magnet of the next succeeding one, thus producing automatic progressive action.

An exterior view of a single unit magnet valve is shown by Fig. 4.

When the magnet is energized its armature is attracted and opens valve from air reservoir to the cylinder. The air reservoir is supplied with air at 70 pounds pressure per square inch from the supplementary control reservoir. The piston making its stroke compresses the piston spring and closes the switch at the same time closing or opening the interlock contacts. When the magnet circuit is open the cylinder exhausts to atmosphere and switch opens through the action of the piston spring. It will be noted that the normal position of the switch is open, and the failure of the air supply or interruption of the circuit opens all the unit switches. The use of air gives great power for closing the switches and renders the operation of them entirely independent of fluctuations of line voltage. Curves shown in Fig. 5 give some data on the relation between carrying capacity and air pressure on the piston head exerted on the contact. A sheet iron

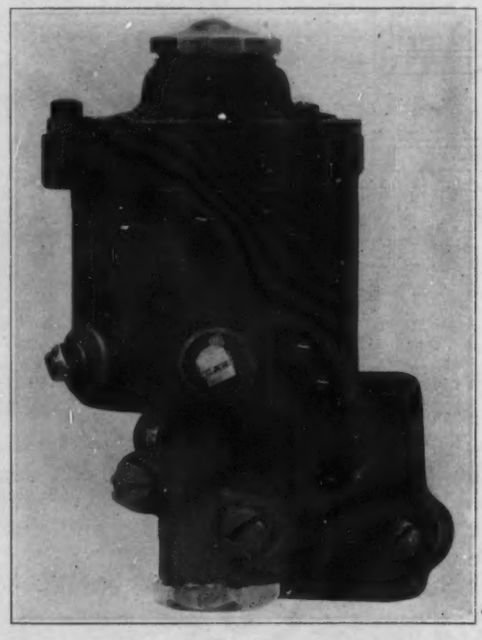


Fig. 4.

cover made in halves which are hinged from the base and easily opened for inspection, effectually protects the switches, interlocks and magnets from dust and moisture. The switch groups are tested with 3000 volts alternating current between main wiring to frame and between all the different wires.

Change-over Switch.

While the Northern Electric Railway's secondary distribution consists almost entirely of third rail construction, it was nevertheless necessary to install overhead trolleys where the line traverses cities and towns. This necessitated wiring arrangements of such a character that third rail shoes would be "dead" while equipment operated within town limits. The old method of attaining this result was either by the use of large knife blade switches, manually operated, or of third rail shoes manually lowered. Both of these systems are cumbersome and inconvenient. An automatic device known as a change-over switch was, therefore, developed for this service.

This change-over switch, an exterior view of which is shown by Fig. 6, consists briefly of a pair unit of electro-pneumatic valves operating pneumatically a block contact held in guides, and operated therein, wiping fingers in contact giving the desired changes in connections to either trolley or third rail circuits. This apparatus is entirely automatic and is operated and protected by two interlocking relays respectively con-

nected to trolley circuits and third rail circuits. The detail of these connections is shown in the "Diagram

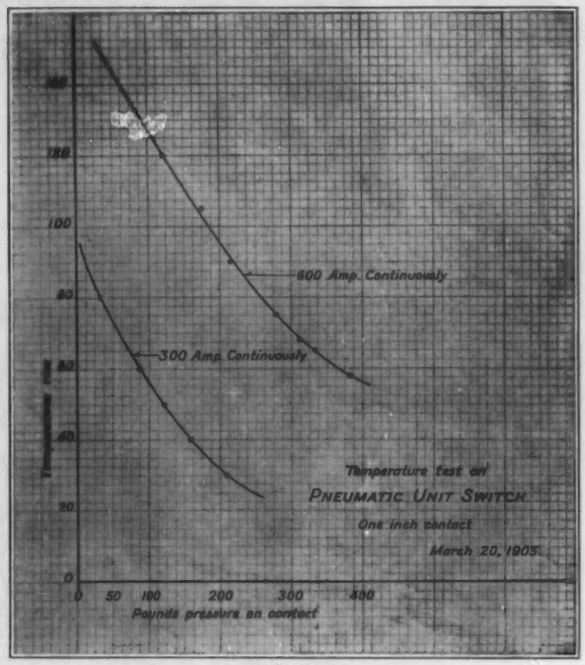


Fig. 5.

of Connection of Main and Control Wiring with Unit Switch Control," as shown on page 384.

Line Switch.

Shown by Fig. 7 closed and by Fig 8 with covers removed.

Current from the trolley or third rail connections after passing through the change-over switch passes then through the line switch. The line switch is a single unit of identical construction with the switch group. It is an independent circuit-breaker provided with automatic overload trip, the trip consisting of a

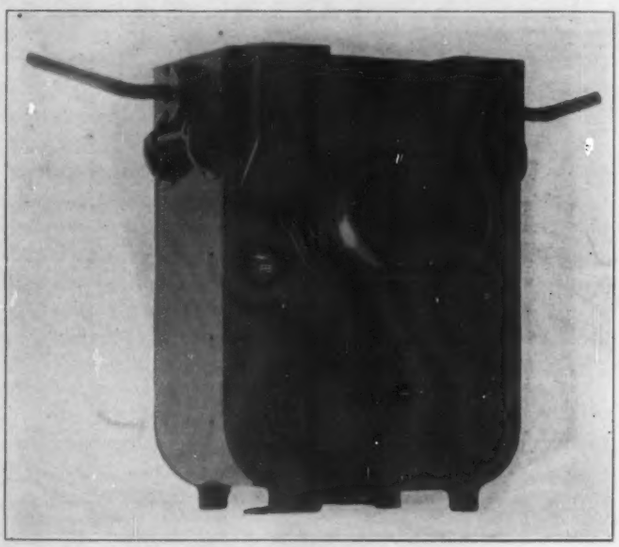


Fig. 7.

plunger acted upon by the blowout coil, the plunger opening a small switch in the control circuit. The trip is also provided with a resetting magnet, the whole being substantially protected by cast iron cap bolted to the main switch and plate.

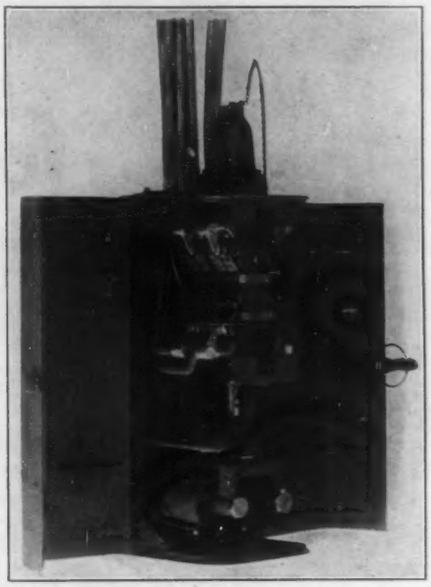


Fig. 6.

Reverse Switch

Shown by Fig. 9 with cover removed.

The function of the reverse switch is to interchange the armature leads of the motors with respect to the field, and thereby reverse the direction of rotation. It consists of two rows of stationary fingers connected through a contact drum rotated by the action of two air pistons, the admission of air being controlled by electro-pneumatic valves similar to those on the switch group and likewise operated from the controller. The drum may be manually moved

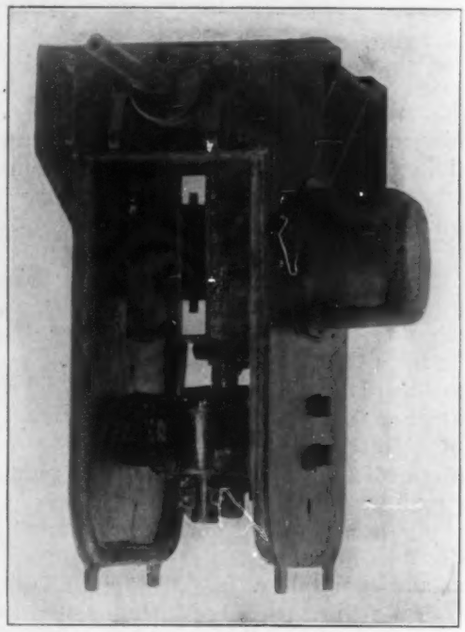


Fig. 8.

to the "off" or "central" position. This arrangement is to open-circuit motors in case the car is being hauled. This open circuiting prevents motors from

"bucking" or generating one into the other. There is also an interlock which acts so that the switch group cannot be operated unless the reverse switch is fully

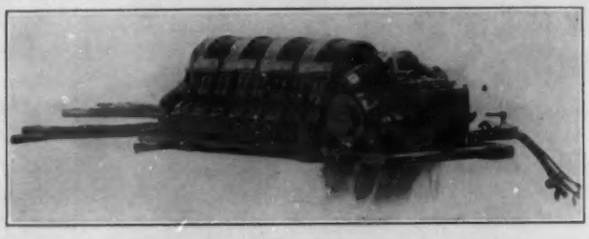


Fig. 9.

thrown in the direction indicated by the master controller, and an interlock closing the retaining circuit preventing reverser from opening while trolley circuit is closed on the motors.

Grid Resistances

Are of the unit type of grid diverters shown on Fig. 10 made up in boxes for facility in mounting and handling.

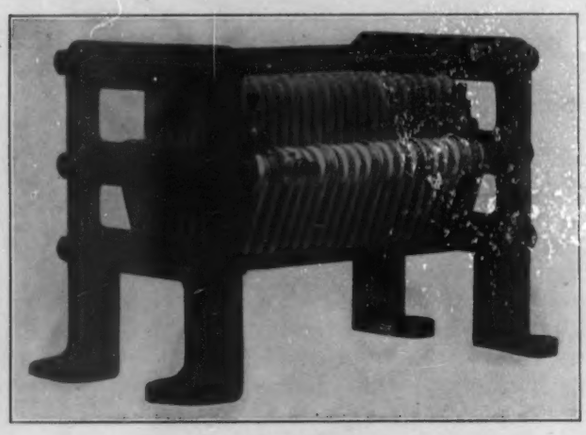


Fig. 10.

Master Controller.

The master controller shown on Fig. 11 is the governing type controlling the switch group and is located in the motorman's cab. It is of simple and compact construction, measuring approximately 7 inches high, 7 inches wide and 5 inches deep. It consists of a movable drum and stationary contact fingers which are electrically connected to the various magnet valves throughout the train. There are three positions for each direction of movement, the "off" position being in the center. These are:

(1) "Switching."
(2) "Series Running."
(3) "Multiple Running."

Intermediate positions of the unit switches can be secured by moving from the running positions. In the "off" position the drum is disconnected from all live wires. When the handle is thrown over without stop to any position; e. g., "Multiple Running," the switches follow in such a sequence that the car starts and is brought up to full speed at a uniform acceleration until full voltage is applied to the motors. This is done without current interruption to the motors at any time.

All current for the operation of unit switches passes through the particular master controller being operated, but control current for each motor-car is obtained from its own battery, so that the number of

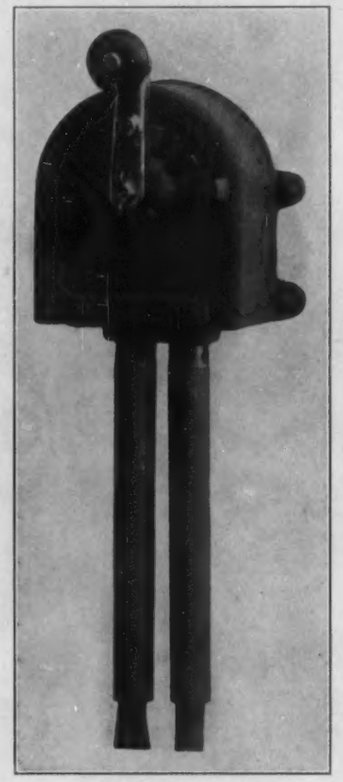


Fig. 11.

cars that may be in a train is not limited. While the operating voltage is 14 volts only, these controllers are submitted to a shop test of 2000 volts alternating current.

Motor Control Cutout.

Shown with cover removed, Fig. 12.

This switch is hand operated and is designed to

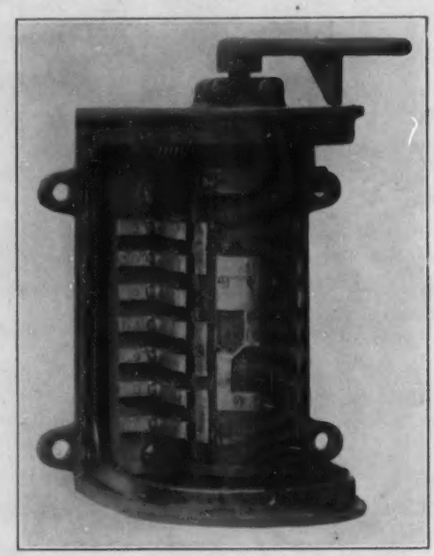


Fig. 12.

cut out operating circuits of certain unit switches, thereby cutting out either pair of motors should they

be disabled. There is an interlock provided which prevents the switch group from reaching the "Multiple" position except when all motors are in circuit.

Limit Switch.

This switch with cover removed shown by Fig. 13.

The rate at which the resistance is cut out of circuit so as to give uniform acceleration current, is

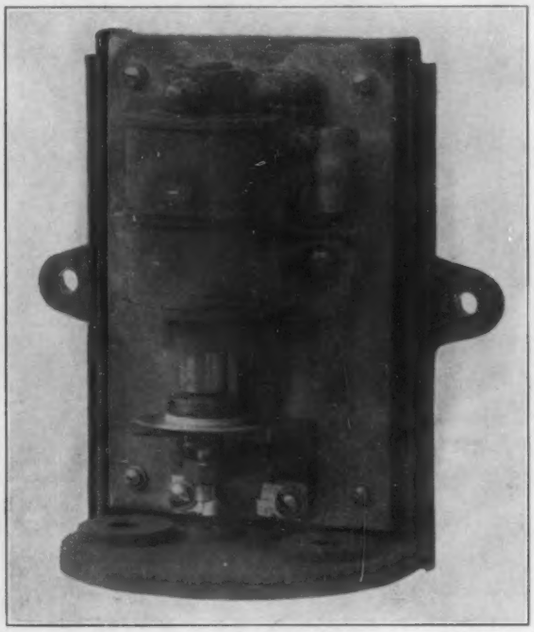


Fig. 13.

affected by the limit switch. This feature is a valuable one as it gives smooth and economical acceleration. It prevents abuse to equipment due to throwing on of power in excess of the predetermined rate.

The limit switch consists of a small switch actuated by a solenoid through the coil of which current of one pair of motors passes. When this current exceeds a predetermined limit for which the switch is adjusted, its armature is attracted against gravity, opening the switch which is connected in the operating circuit, and remains open so that no further unit switches can close (those already closed being retained) until the accelerating current falls below the predetermined limit. The armature then drops again completing the operating circuit and allowing the unit switches to continue their progression of closing. They are thus interrupted at each step of resistance. The limit switch can be adjusted to any desired accelerating current.

Line Relay.

This relay shown by Fig. 14 opens the unit switches should the current supply be interrupted. It consists of an electro-magnet, the coil of which is connected across the supply mains. The armature of this magnet acting against gravity holds three contacts closed in the operating circuit.

Another important function of this device is its interruption of control at third rail gaps and crossings which "drops out" the switch group contactors. Its return to normal when third rail shoes are again in contact with conductor rail restores the switch group control circuits so that the switch group "notches up" progressively restoring the controller connections within the period of a few seconds to the original position. If it were not for this relay interposed in the control circuits full voltage would be impressed upon motors immediately after passing a third rail gap. This sudden rush of current with its allied

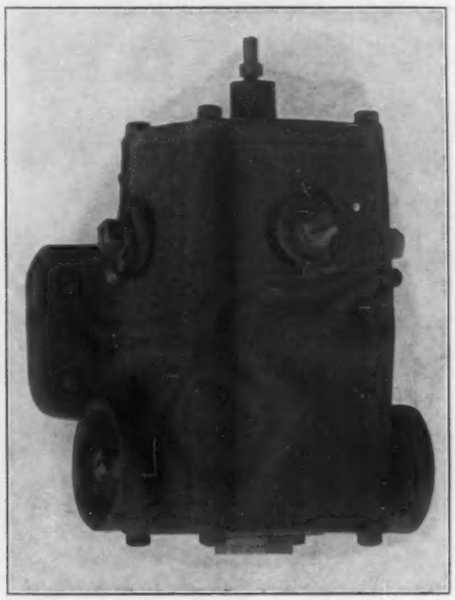


Fig. 14.

magnetic inductive surge would open breakers in sub-stations and otherwise abuse motors and generating apparatus.

Junction Boxes.

Fig. 15 shows a typical view of the cast iron junction boxes in which are enclosed wooden blocks having the requisite number of terminals for control wire connections.

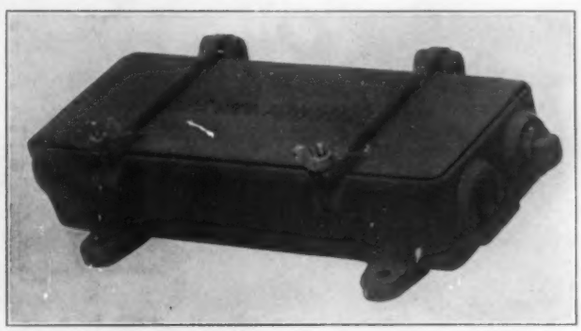
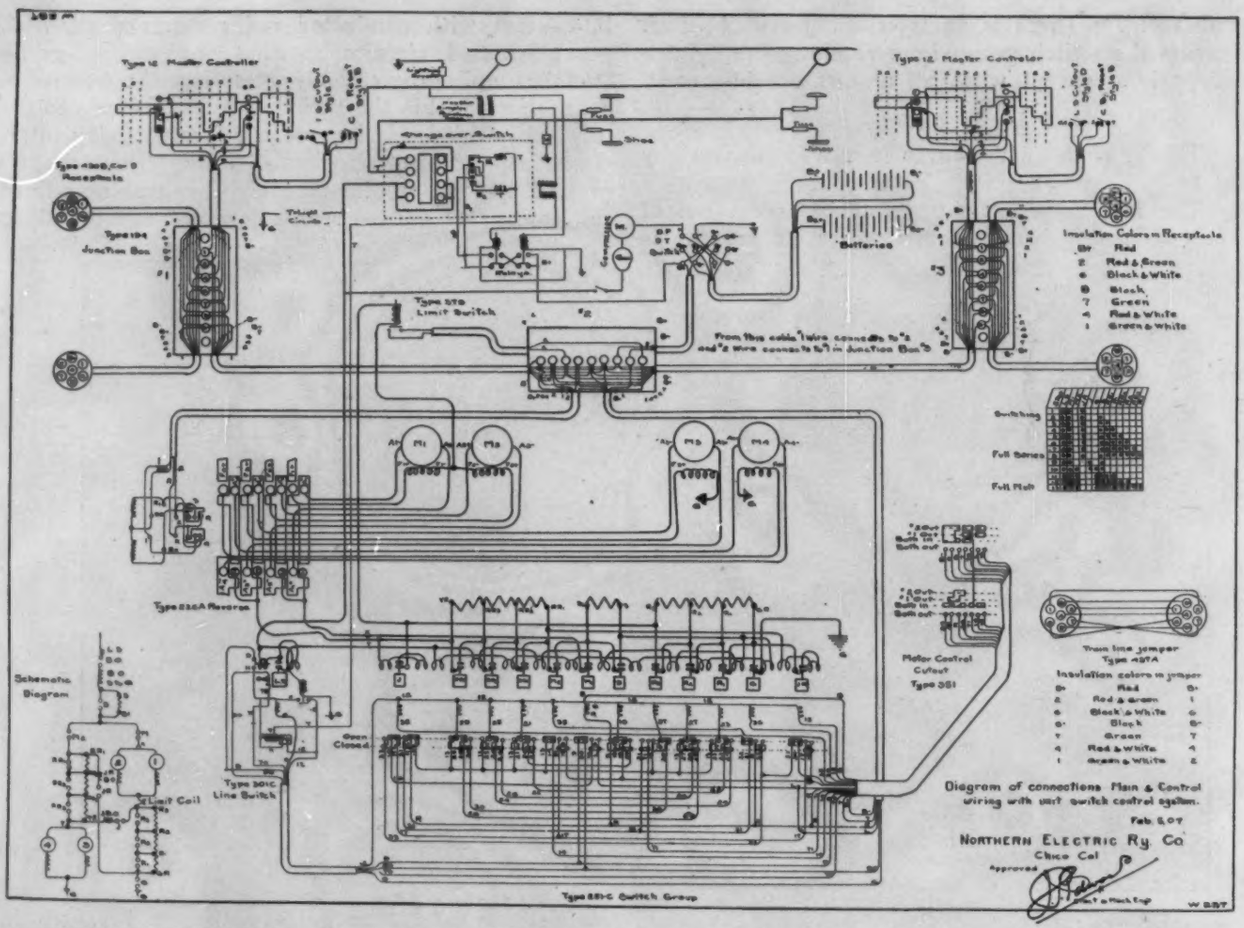
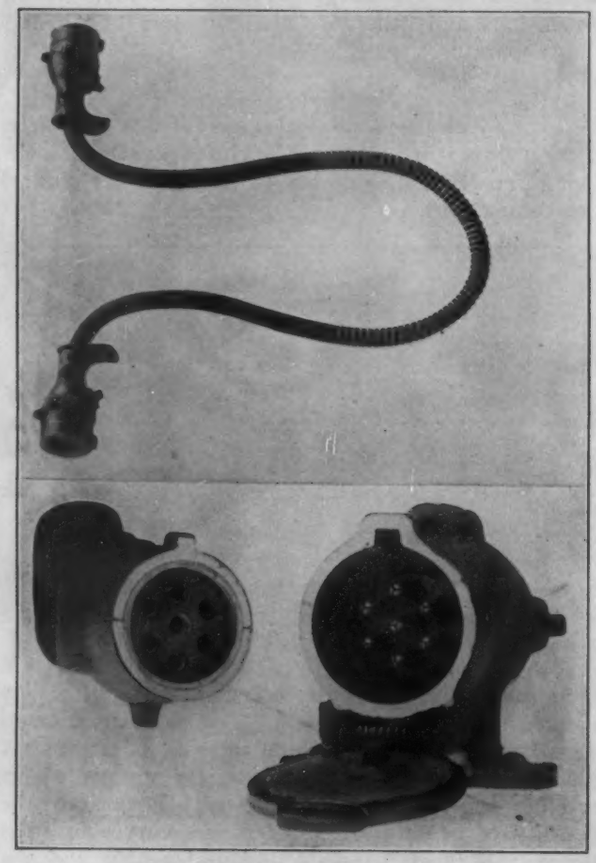


Fig. 15.

Train Line Receptacles.

As illustrated by Fig. 16 are used in train service and are employed to complete the control line bus connections between cars. The usual location of train line receptacles in which train line jumpers, as illustrated by Fig. 17, are located is slightly above the buffers upon one side of the cab. Because of the necessity of negotiating short radius curves in train service, this location was found undesirable and the





Figs. 16 and 17.

train line receptacles have been made an integral part of the radial draft rigging. These receptacles move together with the couplers. Details of this arrangement and a description of the same has been given in another portion of the "Journal of Electricity."

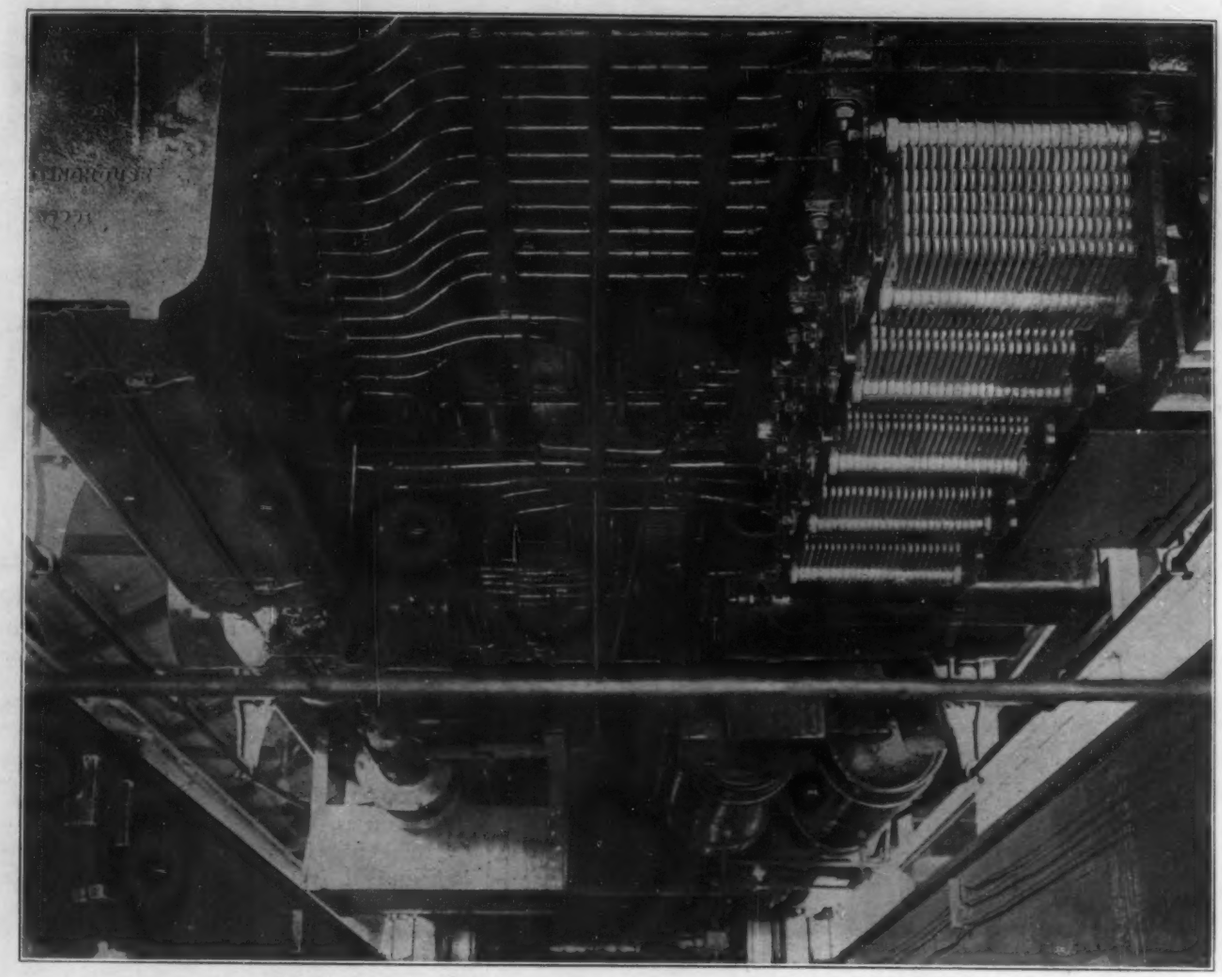
Storage Batteries.

Current for the operation of the magnet valves is secured from a storage battery in duplicate, each consisting of seven cells, having a capacity of 20 ampere-hours. One battery is on charge in series with interior arc lights, while the other is on the operating circuit, these connections being made by two double-pole, double-throw switches.

The batteries of each car are connected to two common leads, which are extended through the entire train as positive and negative of the train line. This connects the batteries of the different cars in parallel. The negative side is also connected to one side of the magnet valves on the same car, making the demand on the battery more or less local.

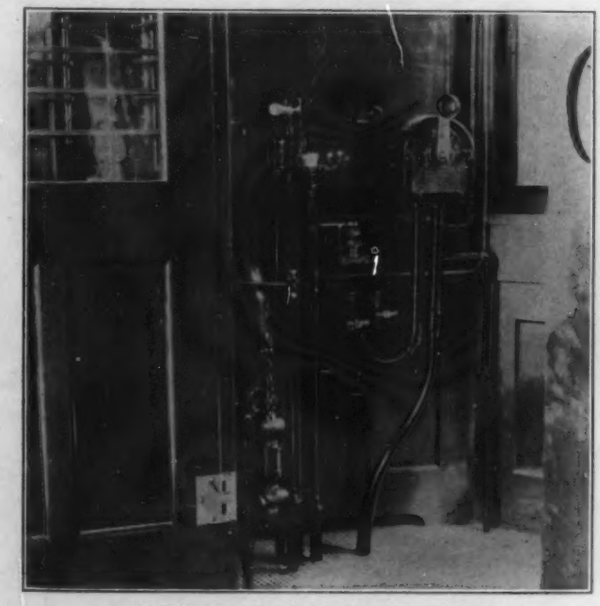
Line Switch Cutout and Circuit-Breaker Reset Switch.

These are two small knife switches located near the controller and conveniently within reach of the operator. By opening the line switch cutout the initial energizing of the control train circuits is opened and none of the line switches throughout the train can close. In this open position of the line switch cutout the switch groups of a train may be operated through their cycles for purposes of test. In a similar manner reversers may be thrown and an emergency braking



Under-Side of Coach Showing the Electro-Pneumatic Control and Air-Brake Systems.

effect secured. This entirely independent of line current or circuits.



Control Apparatus in a Motorman's Cab.

The circuit-breaker reset switch is nominally held open by a spring. The overload trip on the line switch is provided with a catch which, when the switch has been opened by a short circuit or other excessive current disturbance, holds it at that position, keeping the operating circuit open on that car with the master controller in the "off" position. The closing of the reset switch completes the circuit through a magnet, which withdraws the catch from the overload trip allowing the circuit breaker contacts to close.

General.

The control apparatus as above described has been in operation on the lines of the Northern Electric Railway for the past three years. The same has given complete satisfaction and by its performance in service has proven the correctness of its details of design and capacity for continuous operation under the exacting conditions of service required of it.

Sub-stations and Electrical Supply.

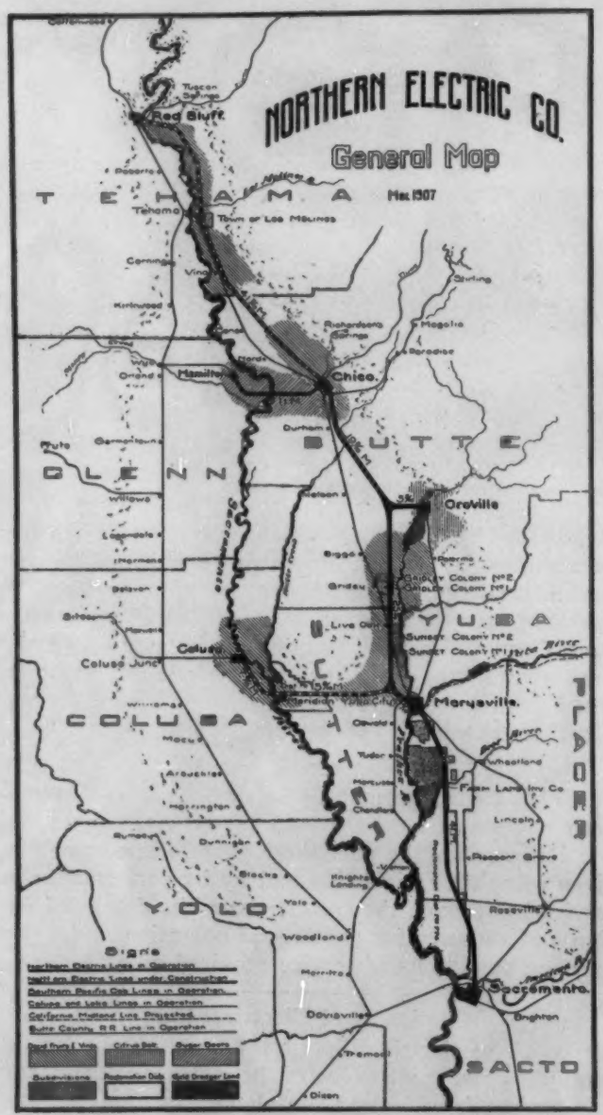
With an electric railroad, the question of a power supply is paramount. One of the features which made this project feasible was the abundant supply of low priced electrical energy, generated by hydraulic power in the nearby mountains, which was available at all points in this system. The question of expensive steam generating plants did not enter into the problem and it was not even necessary to parallel the road with a high-tension distributing line, although this has been partially done.

Electric power is supplied at the low-tension side of the transformers by the Pacific Gas & Electric Company who own and furnish the transformers and high-tension apparatus necessary for use at the sub-stations. All other sub-station equipment, including the buildings themselves are owned by the Northern Electric Company.

There are three standard types of sub-stations in use, which have been designed and built by the engineers of the company. These are distributed so as to energize about 10 miles of road each.

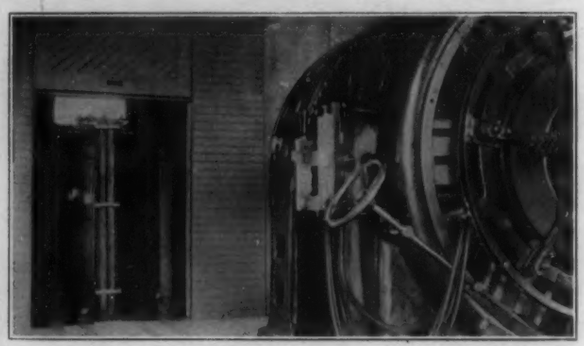
There are at present nine stations, although provision has been made for ten and they are numbered accordingly.

The equipment throughout is similar, both in the type and size of the motor-generator sets and style of switchboard.



Current is supplied from the transmission lines at a potential of 60,000 volts, with a frequency of 60 cycles. It is supplied to the motors at 2000 volts.

Motor-generators were adopted instead of rotary converters, for a variety of reasons; they consist of a Westinghouse, type CCL induction motor, rated at 580 hp., direct connected to a Westinghouse, 6-pole, 600 volt generator of 400 kilowatts capacity. The two machines are set close together, are mounted on a single base, and have but two bearings. This arrangement presents a neat appearance and the machines have proven themselves dependable and highly efficient.



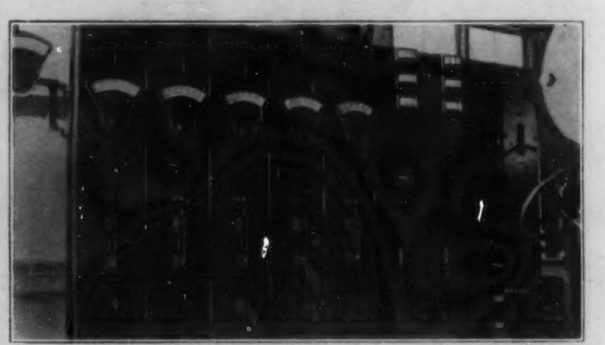
Machines and Transformers, Sub-Station No. 2.

The switchboards are of slate of the standard General Electric type for this purpose and the instruments and switches are of the same make. The switchboards were assembled and the mountings made by the Northern Electric engineers in accordance with their own ideas.

Connection between the switchboard and track are made with 1,000,000 cir. mil copper cable.

The first station is, as before mentioned, at the car house at Mulberry. There are no transformers, as current is supplied from the sub-station of the power company in close proximity. There are two motor-generator sets, so that the total output is 800 kilowatts.

Number 2 is 9.4 miles from Mulberry. It represents one of the types of sub-station buildings adopted by the company. The building is almost square; it has a concrete foundation under the walls, transformers and machines. Provision is made to rapidly drain the transformers of their oil, should a burn-out occur and in carrying out this idea a system of ducts has been incorporated so as to cause a natural draught of air, drawn from beneath the building and next to the ground, where it will be coolest, to pass up



A Sub-Station's Switchboard.

and around the transformer cases and out through special transformer cell ventilators.

The switchboard is mounted well away from the wall and behind it is an elongated pit through which all cables are carried; this is covered with a grated wood floor. The oil-switch for the induction motor is

of the remote control, manually operated type and is contained in a fire-proof enclosure, outside of the building.

The framework of the building is of wood, but it is covered with wire lath which is also used for the panel walls. Two coats of cement plaster both inside and out cover the lath, making a thoroughly serviceable and practically fire-proof building.

At No. 2 station there is but one motor-generator set. There are three, 150 kw. transformers.

Sub-Station No. 4.

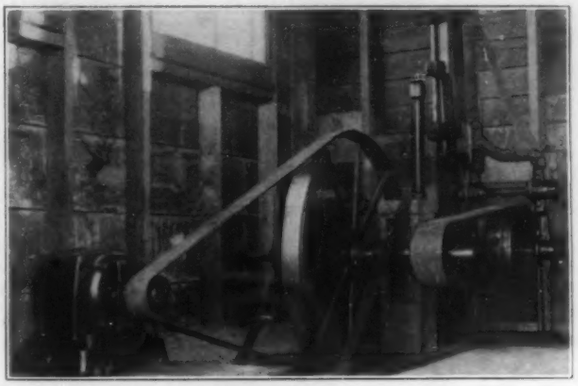
The transformers may be moved forward out of their cells, but ordinarily the opening between the cell and the operating room is closed by a counterweighted sliding door.

Sub-station No. 3 is at Tres Vias and energizes, not only a section of the main line, but the branch into Oroville as well. This station is similar to No. 2 in all respects, except that the transformers are 300 kw. capacity each, and there are two 400 kw. motor-generator sets.

Sub-station No. 4 is again similar to No.'s 2 and 3 and is equipped with one motor-generator set. This station is located near Gridley.

At all the sub-stations, it is necessary to have water for the various purposes of domestic supply, irrigation and as a means for cooling transformers, although some of the transformers are oil-immersed but air-cooled. Water is near the surface of the ground at almost any point, but it is necessary to pump it. A tank elevated to give the proper head for all purposes is supplied from the well by a simple but dependable pumping rig. This is installed in a small pump house near the station and operated by the attendant, whenever necessary.

No. 5 sub-station represents another type in that it is portable. This consists of two standard freight cars, reconstructed however throughout for the purpose. One of the cars contains three 150 kw. lowering transformers. The high-tension lines are brought into the car through three windows. These are 36 in. square and have two glass panes each, the wire passing through a hole at the centre of the pane. High-tension disconnecting switches are mounted on poles outside of the car.



Pumping Rig at Sub-Station No. 4.

The sub-station proper contains one standard 400 kw. set and the accompanying switchboard. One end is partitioned off to make a tool room. This station being mounted on wheels, it is very important that it shall not only be level, but also not subject to vibration. This is accomplished by means of wrought-iron hooks fastened to the under side of the car-body and which grip the ball of the rails. Acting against the strain imparted by these hooks are screw jacks, which bear up against the car-body. The accompanying illustration shows the simplicity of this device and the clearness of the view of the interior, which was made while the machines were in regular operation, proves their effectiveness.

A Portable Sub-Station.

Sub-station No. 6 is in the city of Marysville. Current is supplied from the local station of the Pacific Gas & Electric Company, there are therefore no transformers. This station is similar to Nos. 2, 3 and 4, it is equipped with two motor-generators, but differs in

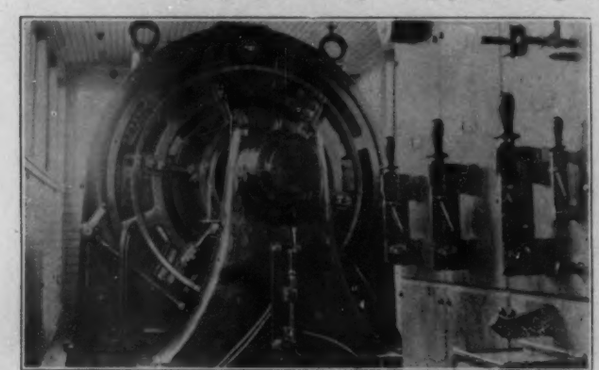
Method of Fastening a Portable Sub-Station to the Track.

the arrangement of the machines, in that, while the building was originally designed for but one machine set, another was subsequently added by invading two of the spaces reserved for transformers, and setting the machine at 90 degrees in respect to the first one.

There is as yet no sub-station numbered 7 and the gap between Marysville and Nicolous, where No. 8 is located is 16 miles.

No. 8 sub-station is the newest and most complete of any yet built. It has a steel frame and the roof which consists of reinforced concrete slabs, is supported on steel trusses. The walls are of reinforced concrete construction. The building has a main floor on which are placed the transformers and two 400 kw. motor-generator sets, arranged much as in the older stations; there is also a second or gallery floor, this contains compartments and high-tension oil switches and is in reality a sectionalizing house for the power company and a switching house to enable this station to derive its source of electrical supply from any one of three transmission lines.

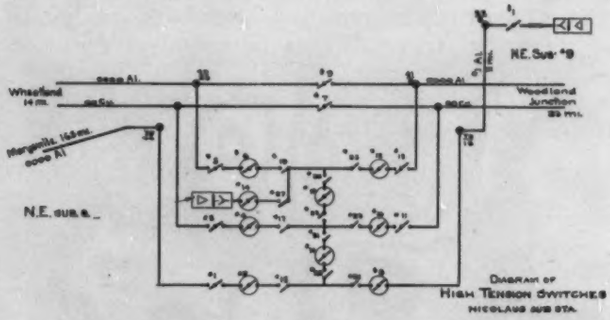
The main, double transmission line of the Pacific Gas & Electric Company between Colgate and Oakland passes through this station. A transmission line of the same company from Marysville, paralleling the



Interior of a Portable Sub-Station.

road also comes to this station and continues to sub-station No. 9. With this arrangement of switches and disconnecting switches which are mounted on poles, outside of the building, current may be taken from the Marysville line or from either of the Bay lines.

The following diagram shows the arrangements of these circuits:



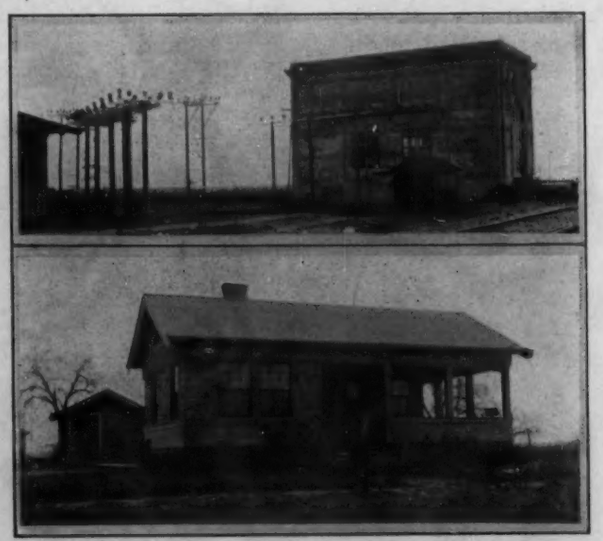
Sub-station No. 9 is of the portable type and is about half way between Nicolous and Sacramento. It is similar in all respects to No. 5.

The last source of energy is at Sacramento. This is derived from the sub-station of the Pacific Gas & Electric Company at 6th., & H Sts. There is one motor-generator set similar to all of the others in use and this is owned by the Northern Electric Company.

The total installed capacity of the sub-stations is 5,200 kilowatts.

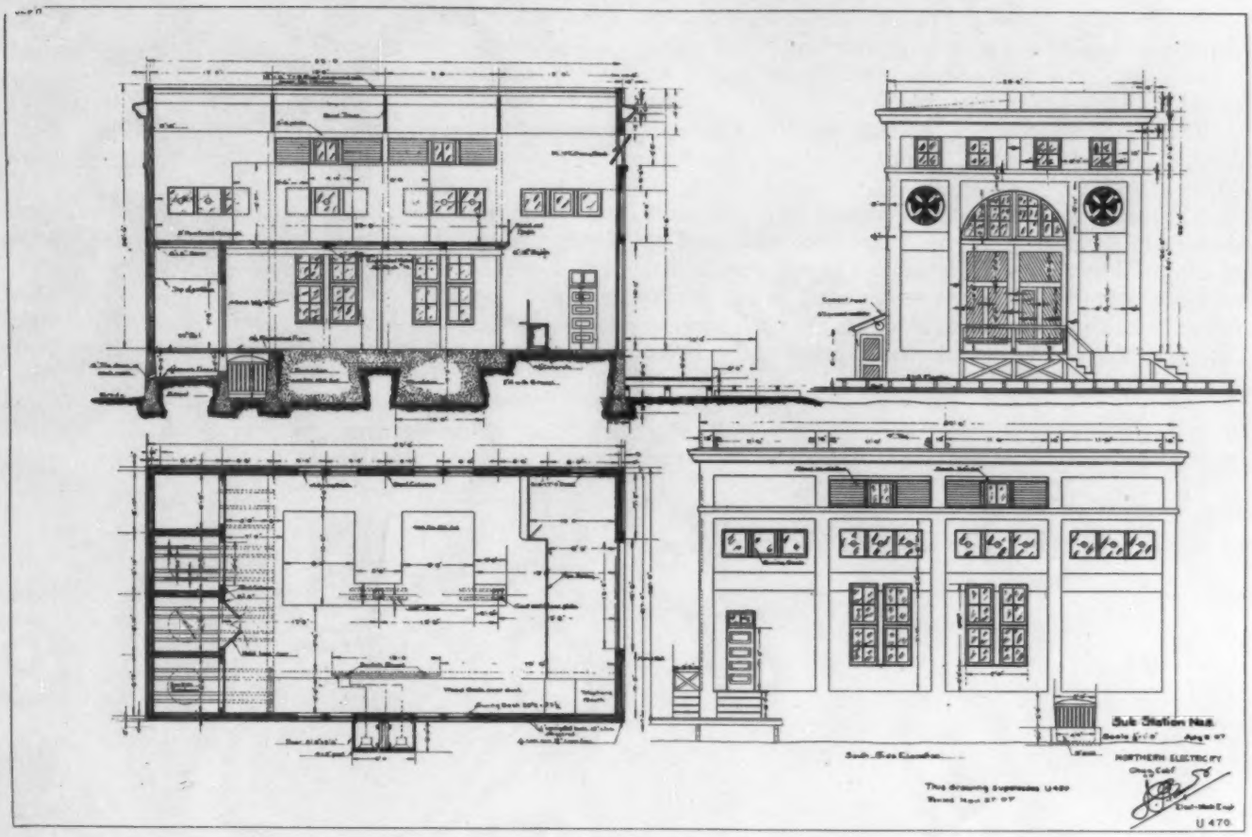
The cost of two sub-stations (not including transformers and high-tension switches, which are the property of the power company), representing the two stationary types, is as follows:

	No. 4.		No. 8.
Capacity	400 kw.		800 kw.
Cost.			
Property	$ 400		$ 250
Foundation	3,100		1,850
Building Superstructure	"	(inc.)	6,400
Electrical Machinery	6,600		13,200
Switchboard	1,500		3,000
Pumping Plant	160		180
Tank	690		300
Erection of Machinery and Installation.	500		1,000
Cartage	1,200		600
Incidental Expense	300		750
Total	$14,450		$27,530



1. North Side of Nicolaus Sub-Station.
2. Type of Cottage for Sub-Station Operators.

Electricity supplied from the transmission system is measured on the alternating side of the motor-



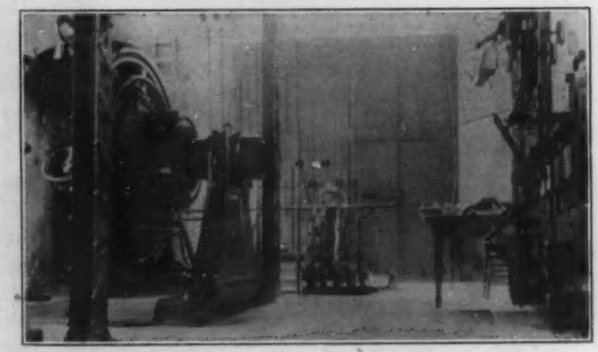
generators. For this reason all calculations of efficiency and losses between the power supplied and the trains are based on these measurements.

The motor-generators are operated in such a manner as to pick up the load as it comes on, thus maintaining a high converting efficiency at all times.

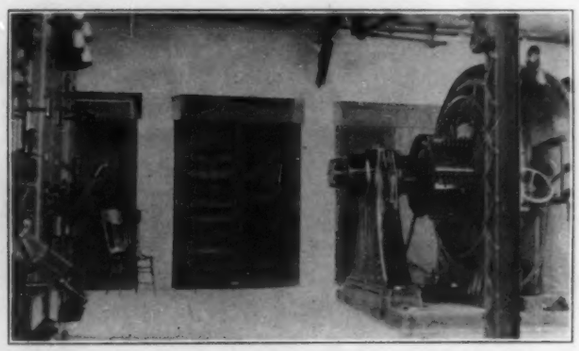
The efficiency of transformation from the alternating current side of the motor-generators to the

Portable Transformer Station.

Sub-Station No. 8 at Nicolaus.



Machines, Switchboard and High Tension Switch-Levers in Sub-Station No. 8.



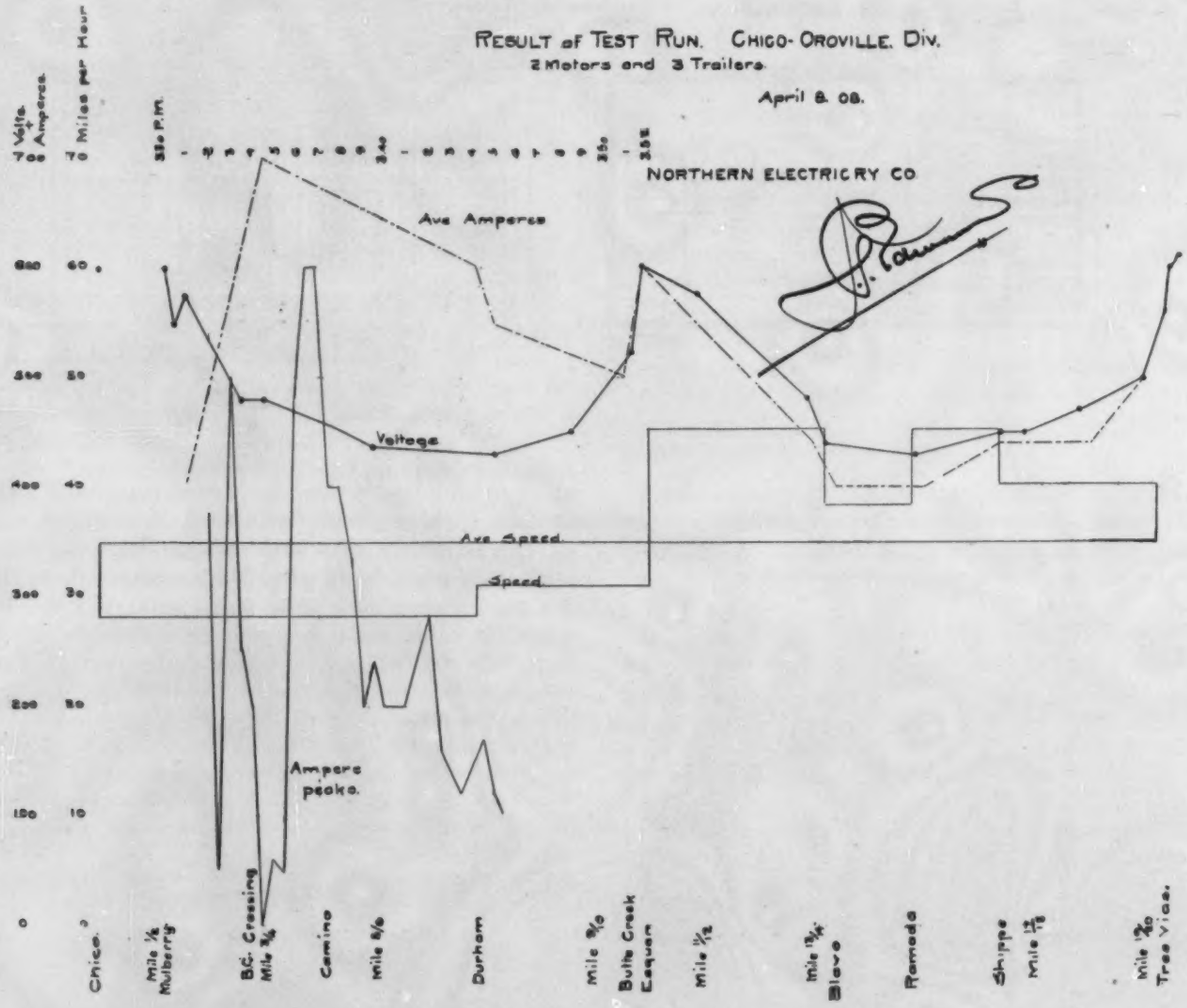
Machines, Switchboard and Transformer Cells in Sub-Station No. 8.

direct current at the switchboard varies in different stations, due to the character of the load, from 50 to 80 per cent. The average for all sub-stations is 66 per cent.

The distribution losses between the direct current switchboard and the train, taking an average from all points, is 6.05 per cent.

The amount of power consumed per car mile, taken from data covering the year 1909, measured at the alternating current side of the motor-generators, is 4,266 watthours. The consumption of power, measured as before, per ton mile, for passenger train service, is 113 watthours. The actual consumption of the direct current at the train is 69.73 watthours per ton mile. During an average day there is run a total of 1500 car miles.

Following are diagrams showing the results of test runs, giving the time between stations, current consumed, etc.



molito, Oroville, Live Oak, Yuba City, Marysville, Nicolous and Sacramento. At these points train orders are issued.

The road is operated in accordance with Standard American Railway Practice Rules; train order forms "19" and "31" being used.

Throughout the day and the early evening, the road is given over entirely to passenger traffic. Between the hours of midnight and 6 o'clock a. m., all freight transportation is accomplished. Were it not for the possibility of this arrangement, the fast and frequent passenger schedules could not be maintained

Train Operation.

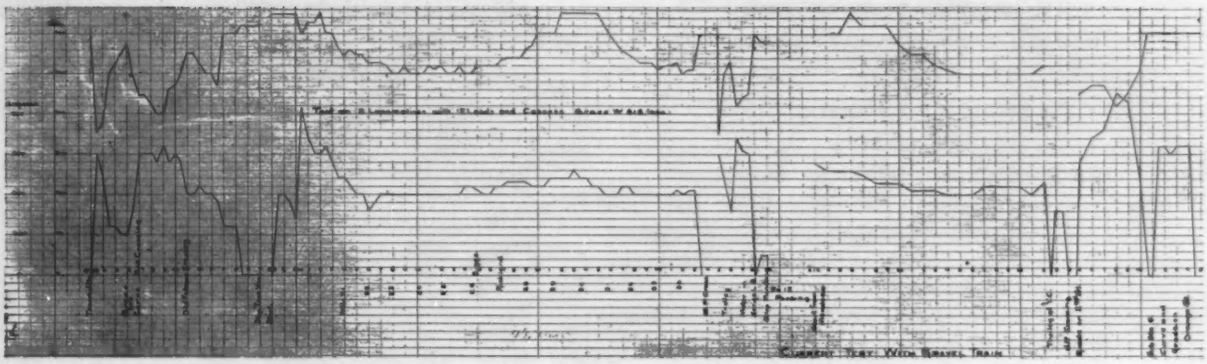
As a rule all trains consist of two or more cars. The first is a combination baggage and smoking car and the second a passenger car. If more than two cars are used, a trailer passenger car is placed in the center of the train. For short runs, where there is need of but one car, a combination baggage, smoking and passenger car is used.

Through trains are run at an interval of about 2½ hours throughout the day and evening. The running time from terminal to terminal is three hours.

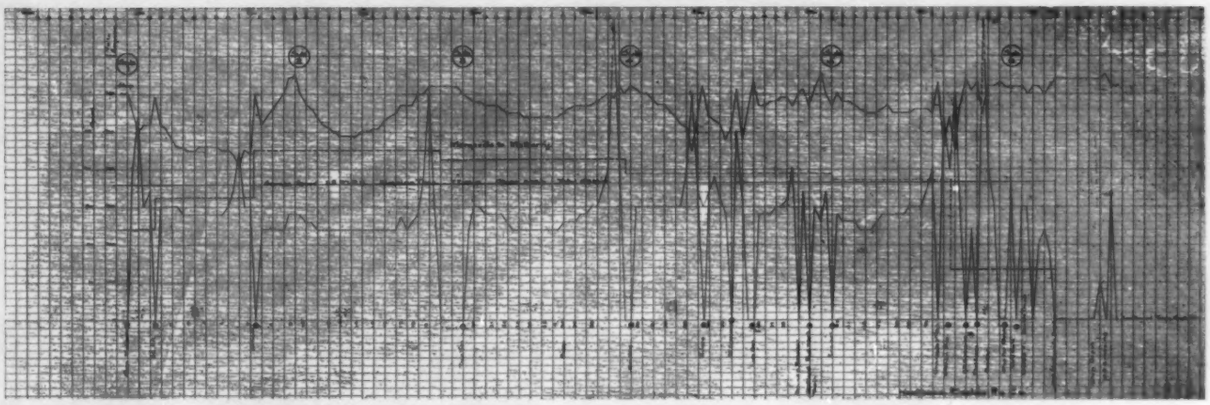
All trains are manned by a motorman, conductor and one brakeman.

A private telegraph and telephone system extends the length of the road, the poles being placed 3 ft. from the western edge of the right of way.

The operating offices, including that of the Chief Dispatcher, are at Mulberry (Chico). Offices having telegraph operators are at Durham, Tres Vias, Ther-



Running Test of Freight Train Between Marysville and Mulberry.



Running Test Between Marysville and Mulberry of Passenger Train.

without seriously inconveniencing freight traffic which is rapidly increasing in importance.

The Northern Electric Company has the distinction of being a thoroughly California corporation; that is, it was founded and is owned and operated by California interests.

The executive offices are at San Francisco; the president is Mr. E. R. Lilienthal; the vice-president, Mr. Louis Sloss, and the secretary, Mr. Norman Logan.

The actual operation of the system is under the supervision of the general manager and purchasing agent, Mr. A. D. Schindler, whose office is in San Francisco, and who is responsible for the admirable results obtained. He has an able assistant in Mr. Melville Dozier, whose headquarters are at Mulberry. Mr. J. P. Edwards is, as before stated, the electrical and mechanical engineer, and to him is due the credit of the design and construction of the varous electrical and mechanical features.

All of these gentlemen have given the writer every assistance possible in his attempt to make an accurate and creditable description of this system, of which all Californians may feel proud.

Five-Car Northern Electric Train.

THE WATTHOUR METER.

BY WM. M. SHEPARD AND ALLEN G. JONES.

CHAPTER VI.

MISCELLANEOUS.

(Continued.)

The Pre-Payment Watthour Meter.

The prepayment device as applied to the gas meter has demonstrated its usefulness after a number of years of service, it being especially valuable in cities where many of the consumers are transient residents, and also where those served find it a burden to make the usual monthly payments, preferring to pay as occasion demands. The slow introduction of prepayment electric meters has been partly due to the limited demand, because usually the class of people that have been using electricity for light, power, heating and cooking have not been of the kind that would desire or that would necessitate the installation of prepayment meters. Now electricity occupies such a broad field that it may be said to be used by all classes

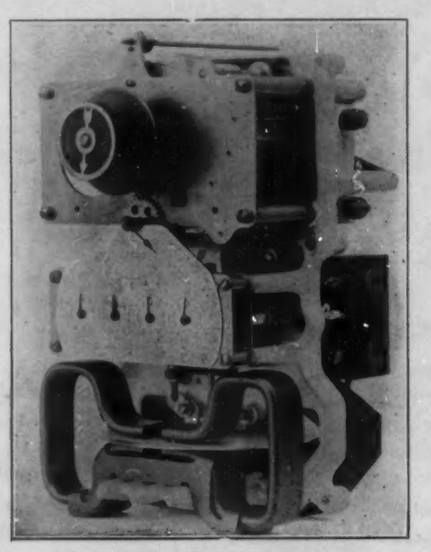


Fig. 73.

of people, therefore the distributing company is often confronted with the problem of "slow pay" customers. Especially is this true with small commercial establishments, such as the poorer classes of restaurants, saloons, tailor shops, etc. The prepayment meter when installed in such places will oftentimes obviate difficulties which may otherwise arise.

The prepayment device can be furnished either as an integral part of the watthour meter, or as a separate device. The construction and operation in either case is essentially the same, except that in the former case the connection to the meter is mechanical and in the latter case it is electrical. Fig. 73 illustrates the prepayment device attached directly to the watthour meter, in which case a pinion in the registering mechanism of the meter meshes directly with the debiting mechanism of the device. In case the prepayment device is used separately from the watthour meter, the debiting mechanism is controlled by an electromagnet which is connected directly in the line, contact being made through suitable gears and commutating device in the meter register.

Fig. 74 shows the prepayment device when used as a separate part of a watthour meter.

Construction and Operation.

The small knob shown protruding from the front of the case is provided with a slot for the reception of coins of the proper denomination. After the coin is placed in the slot the knob is given a half turn to the right, the coin engaging the shaft of the crediting mechanism and the main circuit being simultaneously closed. The coin is carried around with the turn of the knob and released into a chute which conveys it to a coin chamber in the base of the meter. The first coin placed in the slot will cause the indicating hand to move to the figure "1" on the crediting dial, the second coin will cause the hand to move to the figure "2," and so on, provision usually being made to accommodate twelve quarter dollar coins at once. Thus $3,00 worth of current may be paid for in advance, and as each quarter's worth is used, the debiting mechanism will cause the indicating hand to recede to the next figure. The dial, therefore, only indicates the number

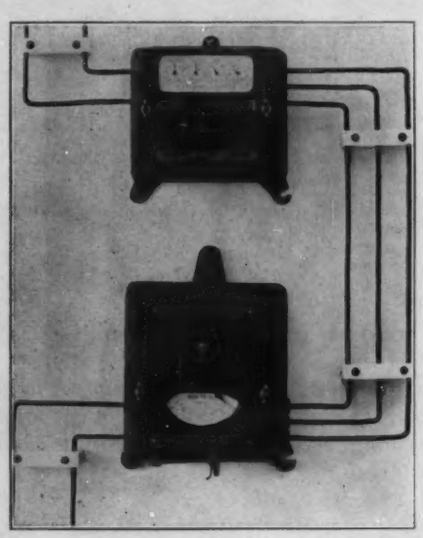


Fig. 74.

of coins to the credit of the consumer and does not take into account the coins for which energy has already been delivered. The total number of coins placed in the device can always be readily translated from the watthour register by multiplying the reading in kilowatt hours by the rate per kilowatt and dividing the result by the denomination of the coin. When all the energy which has been paid for has been delivered, the crediting hand moves back to the zero position and opens an internal switch, which cannot be again closed until another coin is deposited. The switch contacts are made of laminated copper strips which insure good electrical contact.

The force which actuates the debiting device consists of a large spiral spring. This spring exerts practically a constant force, since it is so designed that it is always operating under a low percentage of its maximum tension. The gearing mechanism of the spring is "differential" in operation, so that the escapement is independent of the knob. This permits the consumer to place more coins in the device before all energy paid for has been delivered, without in any

way disturbing the crediting and debiting mechanism. The prepayment device is usually made for rates ranging from 5 to 20 cents per kilowatt-hour in steps of one-half cent. Each prepayment device is marked with the rate per kilowatt-hour with which it should be used; if, however, it is desired to change this rate of charge it is only necessary to change the gear ratio of the "rate device," the construction being such that this is easily accomplished. The coin receptacle is in the back of the meter and so located and protected that the meter cover may be removed (for testing and inspection), without giving access to the coin receptacle. It consists of a drawer which can be slipped in or out from the bottom of the meter case, so that it is not necessary for the collector to remove the meter cover when taking out the coin. Lugs (as will be seen from the illustration) are furnished so that the coin receptacle can be locked by means of a suitable padlock.

The manufacturing companies have perfected the prepayment device to such a degree that it is as trustworthy as the gas meter device, and they have designed it so that "beating" is practically impossible. When a coin is once placed in the slot, the knob cannot be turned back until a half turn has been completed and the coin has dropped into the chute. A coin of smaller dimensions than that for which the slot is designed will not allow the knob to be turned. The credit knob is provided internally with a sharp edge which will shear off any thread or fine wire that may have been attached to the coin with fraudulent intentions.

The prepayment attachment for the electric meter has the advantage over the gas device in that it may be placed at any point remote from the meter which it controls. The electric meter may be in the attic, the basement or on the back porch, and the prepayment device in the kitchen or other convenient place.

The following diagrams show the connections of the prepayment device above described when used in connection with alternating and direct current watt-hour meters as manufactured by the General Electric Company.

The Wright Demand Indicator.

The need of an instrument which will indicate the maximum demand made upon the current supply of a distributing company has lead to the development of the device shown in Fig. 76, which is known as the "Wright Demand Indicator." As will be noted from Chapter VIII, relative to rates, the cost of serving a customer whose average load for 24 hours, compared with his maximum, is high, will be lower than the cost of serving a customer the ratio of whose average to maximum load is low. In other words, the customer with a good "load factor" is more profitable to the distributing company. For example, suppose that a given customer has a connected load of lamps amounting to 10 kw. which are being supplied with current for only two hours in the evening, and suppose that another customer has a connected load of motors amounting to 2 kw. that takes current for ten hours. In either case, the kilowatt-hours per day are the same, but the lighting load comes when the demand upon the station is at the highest point; whereas, the motor customer is being served when the generating machinery would otherwise be running partially loaded. It is therefore evident that the customer whose demand is practically constant, such as the motor customer, is the most profitable, and is entitled to a better rate.

The Wright Demand Indicator can be, and is used to great advantage in determining the maximum load on transformers. Its systematic use in determining the actual maximnm loads on the transformers of a distributing system will insure the transformers against excessive overloads. As is the case with meters, it is not infrequent that transformers of too large a capacity are used for supplying a given connected load; the maximum demand indicator is valuable in determining the proper capacity of distributing transformers. The indicator may be mounted on the pole and connected in the circuit by replacing one of the primary fuse-plugs with the plug having loose connections which are attached to the terminals of the indicator. When the indicator is used in this way it should be mounted on a suitable board, which will

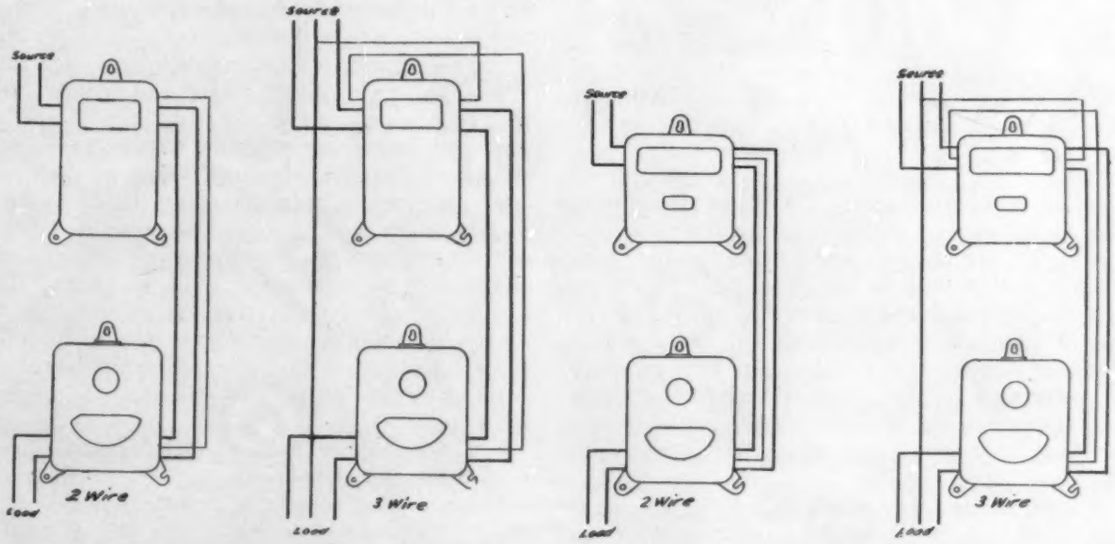


Fig. 75.

D. A. C

facilitate handling and also prevent breakage. The indicator can also be applied to motors driving machine tools, etc., to ascertain whether or not they are being operated in excess of their guarantees.

Around the upper, or left hand bulb, shown in Fig. 76, and in close thermal contact with it, is a band of resistance wire through which passes the main line current or a proportionate part thereof; shunts being provided with high capacity direct current indicators.

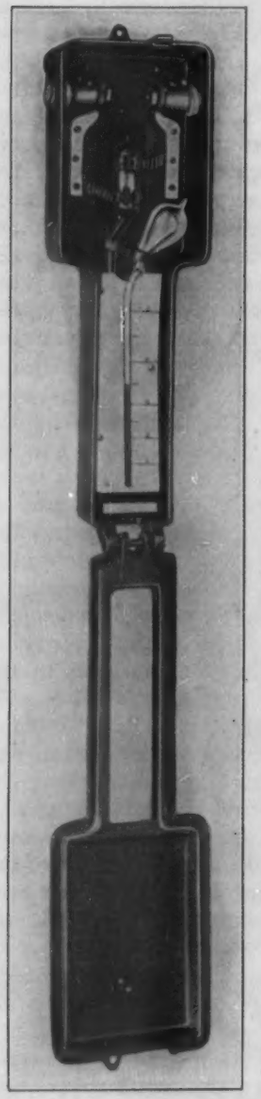


Fig. 76.

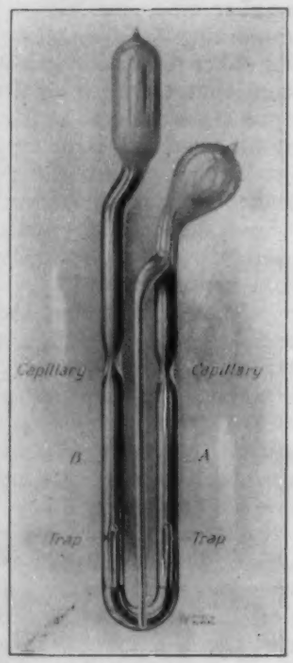


Fig. 77.

and current transformers with the larger sizes for use on alternating current circuits. The current in passing through the resistance band heats the air in the glass bulb, which in turn causes the air to expand, thereby forcing the liquid up into the right-hand tube, the liquid then falling into the central or index tube, which is set in front of the scale. The heat generated in the resistance band is proportional to the square of the current passing through it (watts dissipated in resistance = resistance X the square of the current flowing).

The difference in temperature of the air in the two bulbs causes the liquid to flow as it does, and since any external temperature affects the air in the two bulbs similarly, no error will result due to changes in temperature of the surrounding air.

The tube is reset by simply tilting it and allowing the liquid to flow out of the index tube back in to the U tube. In resetting the indicator, air bubbles from one arm of the U may be carried over into the other arm, thereby unequalizing the pressure and causing the calibration to be disturbed. To prevent this trouble, the little traps shown in the illustration are located in the bottom of the U, and when the tube is inverted (or partially so), they remain covered with the liquid, due to the action of the capillaries in the channels of the U tube, and thereby prevent the passage of air from one side of the U to the other side.

The Induction Type Watt Demand Indicator.

The Wright Demand Indicator which has just been described deals with the current only, and does not take into consideration the power factor of the circuit on which it is used nor fluctuations in line voltage. It is often necessary to know the maximum watt demand, especially in the case of motor installations.

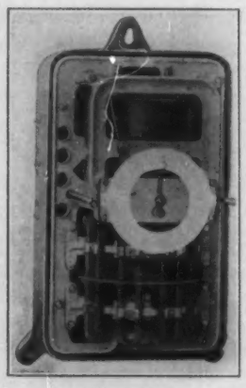


Fig. 78.

To fulfill the requirement of such a device the General Electric Company has designed the instrument shown in Fig. 78, which is known as the "Polyphase Maximum Watt Demand Indicator." This instrument will indicate and register the maximum watt demand on single, two or three phase systems having a balanced or an unbalanced load, and irrespective of the power factor and voltage fluctuations.

This type of indicator is simply a modification of the polyphase watthour meter, the ordinary retarding magnets being replaced by a greater number of very powerful permanent magnets arranged as shown, and with both electrical elements acting on the upper disc. The register as ordinarily furnished on watthour meters is replaced by a circular scale having two concentric pointers, one of which is connected to the disc shaft through a suitable train of gears; the other pointer being driven by the first pointer. As the load on the indicator causes the first pointer to deflect, the second pointer is carried to the maximum position reached by the first pointer, in which position it is held by a ratchet.

The upper, or "motor" dics is opposed and controlled by phosphor-bronze springs which confine the rotation of the disc to a definite number of revolutions. The torque acting on the disc is proportional to the power passing through the indicator, therefore

by using a control spring of many convolutions, the graduation of the scale can be made uniformly.

A curve showing the relation of the percentage of deflection to the time during which it takes the pointer to reach such deflection is shown in Fig. 79. It will be noticed that the curve rises very rapidly until the 90% position is reached, and that the time from 90% to 100% is relatively great; for this reason the indicators are usually rated by defining the time lag as

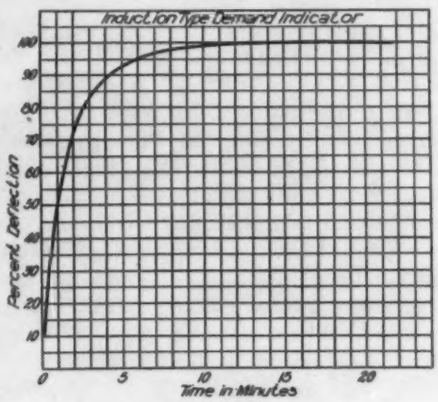


Fig. 79.

the interval of time taken to record 90% of any change in load. The time lag depends upon the torque of the electrical element and upon the retarding effort of the permanent magnets; by altering the effect of these two factors, a time lag from one to thirty minutes can be secured. By changing the position of the retarding magnets in an indicator having a definite rating, the time lag may be varied from 10% to 15%.

The polyphase maximum watthour demand indicator can be used on single phase circuits by connecting the potential coils in multiple and the current coils in series and dividing the scale deflection by two.

(To be continued.)

PRACTICE VS. THEORY AND THE RESULTING COMPOUND.

BY M. C. LORD.

The first consideration of a graduate from an engineering college after being filled with theory (unless father has money to burn) is a job where he can experiment with his theory and put it into practice. The job he gets depends on his training, personality and ability to sell his knowledge. If father has influence, these things may be modified somewhat; but assistance gained along these lines is often detrimental later. The man with the high technical training often conceives the idea that no position less than the general manager of a large corporation would be commensurate with his dignity and training and immediately proceeds to secure the position. But, alas! he finds the position held by a man who has secured his training in that greatest of universities—experience. After awakening to the fact that all the large corporations manage to make the wheels go around without his assistance, with no vacancies in the position he seeks, it is possible he may secure a position as a helper, to a lineman, for instance.

Now, his fellow-workmen will consider him an outsider. In accordance with his training, he hesitates to soil his hands, which makes the boys feel like handing it to him; which they generally do by giving him false information at every opportunity. It is with great difficulty, if he can swallow his pride and take it good-naturedly, that he at last gets at the facts of the case and gains such practical experience as will enable him to apply his theory to practical use.

The fault in most cases lies at the door of the institution from which he graduated. The professor perhaps is a graduate of a similar institution, and immediately began his career as a teacher, having had no practical experience in the application of the theory he is propounding.

Herein lies the reason why we find so many university graduates handling those well-known tools claimed as a heritage by the descendants of the Emerald Isle. For many of our university men are educated out of a job in the line of work for which they are preparing themselves, and the job is held by the man who is a graduate of that greatest of all universities which without an entrance examination we are all compelled to attend.

The practical man has not the opportunity to complete the high school in many cases, before entering into competition for an existence, and if he has chosen a trade, must serve his apprenticeship of four years, probably the first two of which were spent in carrying and cleaning tools, doing odd menial jobs, etc., about the shop; and then perhaps he is put to work on a job, which we will say is winding a machine. He will probably spoil the first one and waste some material, which is of course at the expense of his employer. He has acquired the experience to do a job of this particular kind, and as he has the ability to earn some money for his employer (who is human, and the law of preservation applies to business the same as life), the employer is loath to invest in any more experience for the employee, and of course keeps him on the same job if possible until his apprenticeship has been completed, when the employer has another boy ready to commence the task he will quit. The employer feels that the journeyman he has turned out is not competent to hold a journeyman's job in his shop, due to a lack of experience.

Now the young mechanic starts out for his university education, if he has the right kind of stuff in him, is ambitious and studies, gets a job and works his way to the top; while the university man works his way down to the plane of practicability, and (if he has the right kind of stuff in him), works his way up again.

Now the man wanted requires both practice and theory, and the time must come when they will be taught together as they should be, but such will not be the case until the professor has a practical knowledge of what he is teaching.

The words "may," "should," should be stricken out of lectures, and the words "it is done this way," substituted, but when you are telling a man how something is done and you do not know yourself, the above words are beautiful sidetracks upon which to shunt the too inquisitive student. If a student should visit all the technical bookstores in the city of San Francisco, I will venture the assertion that he will not find a book which will tell him how to connect one of the standard types of induction motors for different voltages and speeds.

RIGHT OF ELECTRIC COMPANIES TO CONDEMN LANDS.

BY LEO H. SUSMAN.[1]

To what extent private property may be taken by electric light and power companies when it is required to enable them to generate or trasmit electricity is an interesting problem. It is a question of great practical importance to a concern like the Pacific Gas and Electric Company, with its miles of transmission lines, flumes, and ditches extending over more than a score of counties.

The power of eminent domain, or as it is more popularly called, of condemnation, has been defined as the right of a sovereign state to appropriate private property to particular uses for the promotion of the general welfare. This power is inherent in and an attribute of every independent state of government by virtue of its sovereignty.

The constitutions of the various states of the union contain provisions relating to the power of eminent domain. They differ somewhat in the language employed, but practically all of them limit the right to such cases only as involve a public use. The constitution of California provides that "private property shall not be taken or damaged for public use without just compensation having been first made to, or paid into court for, the owner." (Article 1, Section 14.) No definition of public use is given in the California constitution, and it therefore becomes of prime importance to determine what is a public use in each particular instance. If the use in question be public, there can be no constitutional objection to a statute permitting the taking. But if the use be private, the taking is impliedly forbidden by the constitution of California.

The California law provides that the right of eminent domain may be exercised in behalf of the following public uses: "12. Canals, reservoirs, dams, ditches, flumes, aqueducts, and pipes and outlets, natural or otherwise, for supplying, storing, and discharging water for the operation of machinery for the purpose of generating and transmitting electricity for the supply of mines, quarries, railroads, tramways, mills, and factories with electric power; also for the applying of electricity to light or heat mines, quarries, mills, factories, incorporated cities and counties, villages, and towns; and also for furnishing electricity for lighting, heating, or power purposes to individuals or corporations, together with lands, buildings, and all other improvements in or upon which to erect, install, place, use, or operate machinery for the purpose of generating and transmitting electricity for any of the purposes above set forth. 13. Electric power lines, electric heat lines, and electric light, heat, and power lines." (Code of Civil Procedure, section 1238.)

The California legislature has declared by statute that private property may be condemned for certain designated uses. At first glance this may appear to be conclusive that property may be taken for any of such uses. But the fact that private property may be taken does not imply that it may be taken for private use. To illustrate: If one man own a city lot and another desire that lot for the purpose of erecting thereon and conducting an office building, the prospective builder can not force the owner of the lot to sell the land to him, as the erecting and conducting of an office building are essentially a private use, one in which the public has no concern. Suppose that the California legislature should enact a law providing that the erecting and conducting of an office building constitute a public use and that private property may be condemned therefor. Can the mere declaration by the legislature that a private use is a public use make it so? The California supreme court, in consonance with the views of many other authorities, has denied the California legislature this power, holding that the legislature can not, in the exercise of the power of eminent domain, permit the taking of private property for a purely private industry and that when it appears plain that property is sought to be taken for a purely private use, courts are not bound by the legislative declaration that a certain business is a public use. In a recent case Judge Gilbert, speaking for the United States circuit court of appeals, said: "The legislature can not by its enactments make that a public use which is essentially a private use, and the question whether the use is public in its nature is a judicial question to be determined by the courts. But it is the general rule that where it is uncertain and doubtful whether the use to which the property is proposed to be devoted is of a public or a private character, the legislative determination of the question is of persuasive force, and the courts will not undertake to disturb the same." (Walker vs. Shasta Power Company, 160 Fed. Rep. 856.)

The mere fact that the public is interested incidentally in the operation of a business and that the use may benefit the public in some collateral way does not make it a public use. In a recent case, decided by the supreme court of Minnesota, it was held that a use is not public unless the person or corporation seeking to condemn property can be compelled, under proper police regulations, to supply the public with the service or use for which the property is sought to be acquired. In this case the plaintiff company sought to condemn lands for the construction of canals and for the creation of a water-power plant that would generate and distribute electricity for light, heat, and power purposes and supply water power. The court held that while the generation of electric power for sale to the general public on equal terms is a public enterprise and the property so used is devoted to a public use, the creation of a water-power plant to supply water power from its wheels is not for a public use for the reason that only a few persons can purchase water power from the wheels. The court declared: "Water power from the wheels must be used at the wheels, and the actual result necessarily is that a very few individuals will use that power for manufacturing purposes to the exclusion of all other persons. The effect is the creation of a power plant to create water power to sell to a few manufacturers for use in their private business. Under such conditions, the willingness of the power company to sell power from the wheels to the general public has only a theoretical value."

The difficulty in determining whether or not a given electric power or lighting business is for a public use is not so much over the legal principles involved

[1]Pacific Gas and Electric Co.

as over the proper application of those principles to the facts of each particular case.

In some states the generation and sale of electricity under certain circumstances have been held not to be a public use. But in the majority of jurisdictions where the question has arisen the generation and sale of electricity have been held to be a public use wherever the company proposing to exercise the power of eminent domain must serve the public fairly and without discrimination.

In the case of Rockingham County Light and Power Company versus Hobbs (72 N. H. 531) the supreme court of New Hampshire said: "The knowledge recently acquired concerning electricity has made it possible to divide power into any desired portions and freely to transmit the same to almost any point for use. This has created a demand for power, which, though not so general as the demand for water, is nevertheless of a public character. Like water, electricity exists in nature in some form or state, and becomes useful as an agency of man's industry only when collected and controlled. It requires a large capital to collect, store, and distribute it for general use. The cost depends largely upon the location of the power plant. A water power or a location upon tide water reduces the cost materially. It may happen that the business can not be inaugurated without the aid of the power of eminent domain for the acquisition of necessary land or rights in land. All these considerations tend to show that the use of land for collecting, storing, and distributing electricity for the purpose of supplying power and heat to all who may desire it is a public use, similar in character to the use of land for collecting, storing, and distributing water for public needs, a use that is so manifestly public that it has been seldom questioned and never denied."

In some instances the electric company, seeking to condemn, has been incorporated for the purpose of generating and selling electricity to the public generally, and also for private purposes. The right to exercise the power of eminent domain has been denied to such companies where they sought to condemn indiscriminately for both public and private uses. But the fact that such a company was, by its articles of incorporation, authorized to engage in a private enterprise as well as to serve the public, will not prevent it from exercising the power of eminent domain for the public use. In determining whether an electric company is exercising a public use the court is not limited solely by the description of the objects and purposes set forth in the articles of incorporation, but may consider evidence outside of such articles, showing the actual purpose in view.

In the case already mentioned of Walker against the Shasta Power Company the United States circuit court of appeals upheld the validity of the subdivision of section 1238 of the California code of civil procedure relating to the condemnation of ditches for supplying water to hydroelectric machinery. Although the question has not been directly passed upon by the supreme court of California, this decision of the United States circuit court of appeals would be of persuasive force. Both reason and authority being in favor of the validity of this statute it may be taken to be the law in California that a corporation, such as the Pacific Gas and Electric Company, generating and selling electricity to municipalities and their inhabitants for light, for the operation of railways, and for general commercial enterprises, uniformly and without discrimination, is engaged in a public use for which it may exercise the power of eminent domain.

OPERATING COSTS OF THE STOLL TRACKLESS SYSTEM.

The Stoll system is in actual operation at Vienna in connection with the municipal tramways (in the Potzleinsdorf-Salmannsdorf district), at Weidling near Vienna; at Gmund, Lower Austria; at Budweis, Bohemia (opened in November, 1908), and is being installed at Pressburg, Hungary. The last named will have 5.8 kilometers (3.6 miles) of line with four wires, six passenger cars, and one goods wagon, the whole to cost 300,000 crowns (about $60,000).

According to the figures which have been furnished, the working costs of running vehicles on this system are reasonable. The following are given as being the costs in Vienna of running a car 75 miles daily:

Current (1 cent per kilowatt-hour)	$0.40 to $0.60
Tires (total load 4.2 tons)	1.50 to 2.00
Wages (driver only, also for tickets)	1.60 to 1.80
Garage	.30 to .40
Taxes, management, insurance	.80 to 1.20
Repairs, painting, renewals of cars, and conductors	.60 to .80
Total running costs	$5.20 to $6.80

This figures out 7 to 9 cents per mile. The line is 2.2 kilometers (1 1-3 miles) long. It passes through narrow streets and around narrow and sharp corners on a continuous steep gradient up and down, the steepest being 10 per cent for a long distance. In order to meet the extraordinary requirements of an intense summer and Sunday traffic, two separate aerial lines are provided to let the cars pass without stopping. The positive pole of each conduit is connected with the conduits of the city tramways, and the negative pole with their rails. At both termini loops are arranged, so that the cars are continually running round. Four elegantly fitted cars, each for 24 passengers, are doing service on this line.

The Stoll trackless trolley system line at Weidling, near Vienna, is 2.3 miles long and has a tortuous, hilly road, with a gradient of 7 per cent. Three cars, with 21 seats each, were purchased with the idea of conveying 120,000 passengers per annum, whereas 132,000 passengers were carried during four months only, hence two new cars have been ordered. The three cars are doing excellent work, notwithstanding the heavy traffic, 60 to 100 miles being run daily from 5:30 a. m. to midnight; on Sundays 2700 passengers are carried, at fares a little over 4 cents. This can only be done by nonstop runs; the meeting of cars and interchanging of trolley cables needs only 10 seconds and can be done at any point on the way. The mails are carried in a box under the car.

The Stoll line at Gmund is under municipal control and is running on a passenger and postal service between the town of Gmund and the railway station. This line was originally estimated to carry 24,000 passengers a year, but actually carried during the first six months of the service 44,305 passengers.

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Pacific Coast Institute Meeting

In accordance with a recent decision whereby the scope of the American Institute of Electrical Engineers may be so extended that the organization may exert a proper national influence, and its individual members throughout the country receive greater benefits, a meeting is to be held on the Pacific Coast early in May. San Francisco has been selected as an accessible point and the time has been fixed as May 5th, 6th and 7th. This meeting is to be held under the auspices of the High Tension Committee, assisted by a local committee, consisting of Messrs. Geo. R. Murphy, S. G. McMeen, J. C. Hays, and A. M. Hunt. Papers to be presented include "The Developed High-Tension Network of a General Power System," by Mr. P. M. Downing; "Hydro-Electric Developments and Irrigation," by Mr. John Coffey Hays; "Emergency Generating Stations for Service in Connection with Hydro-Electric Transmission Plants Under Pacific Coast Conditions," by Mr. A. M. Hunt; "Observation of Harmonics in Current and Voltage Wave Shapes of Transformers," by Mr. J. J. Frank; "Parallel Operation of Three-Phase Generators with Interconnected Neutral," by Mr. G. I. Rhodes; "Transmission Line Crossngs of Railroad Rights of Way," by Mr. A. H. Babcock. It is expected that in addition to a number of the national officers from the East, including President L. B. Stillwell, there will be a large attendance from the northwest sections and Southern California. Arrangements have been made for trips of inspection over the lines of the Pacific Gas & Electric Company and the power plant of the Great Western Power Company for Eastern visitors during the week following the meeting, and every courtesy in visiting the plants adjacent to San Francisco Bay has been extended by the power companies. As this is the first national meeting to be held on the Coast, we hope that every one of the Pacific Coast members will do their best to make it a success.

Interurban Electric Traction

The electric railway, together with electric power and the telephone, is an able assistant in fostering that "back to the country" migration urged by reformers. Given these city comforts, country life is attractive to all but the most confirmed apartment-house denizen. A development of less than a score of years, the interurban electric road has already become well-nigh indispensible.

The Eastern States have been so grid-ironed with these links of steel and copper that it will soon be possible to travel for nearly one thousand miles from Wisconsin to New York entirely in electric cars. Night travel has been facilitated by sleeping-cars even more convenient than those on the steam roads. Such long-distance travel, however, is but incidental to electric traction's prime province in giving rapid and convenient access from outlying farms and villages and to city advantages.

As for the Pacific Slope we find excellent systems of electric railroads in the Inland Empire, on Puget Sound, surrounding Portland, around San Francisco Bay, throughout California's great central valleys and about Los Angeles. In some places they parallel existing steam roads, while in others they tap a virgin country whose wealth of raw products give a profitable freight business, in addition to passenger traffic.

Wherever they go they bring new settlers to the ranch lands and new blood to the towns. They populate the country more rapidly than do the jack rabbits they displace.

As yet they have seldom proven serious competitors to the steam lines, which have usually profited by the new business created in their territory by the electric road. Local competition is being met either by electrifying steam lines or by running gasoline motor cars. Aside from the frequency of service that is possible with electric cars one of the main advantages of such service is the greater speed that can be safely made with numerous intermediate stops. The fare is generally lower than that of a steam line and the convenience and comfort of the passenger greater. Notwithstanding these advantages it is a brave group of men possessed with the necessary courage to finance a new project in a country which at best may be but partly settled. All credit is therefore due the backers of the Northern Electric Railway, a description of which occupies the major portion of this issue.

Three Cent Fares

Telegraphic reports of profit in the first month's operation of the Cleveland, Ohio, street railway system on the basis of a three-cent fare are being given prominence in the daily press. Some of the more radical of these papers even suggest that a like rate be enforced in other cities throughout the country. Some day, perhaps, a history of the traction experiments of Cleveland may prove the rule and guide to those interested in the regulation of public transportation, but until these experiments have been crystallized into profitable practice they seem but poor models upon which to pattern present legislation. The much-heralded innovations of Tom Johnson have already been discredited by the test of actual use and there still remains a possibility that the methods substituted may not be quite as successful as anticipated.

Under the new system, which is to be tried out for eight months, the initial rate of fare is three cents, with one-cent charge for a transfer. If the rider has not three cents in change, or a cardboard ticket which may be bought at the rate of five for fifteen cents, he is charged five cents for his ride, thus lessening the conductor's work. As a result of this preliminary trial the final fare will be increased or decreased so as to insure a six per cent dividend to stockholders.

It is too soon to predicate prophecy upon the first month's showing, but aside from the controlling feature of legitimate dividends to investors there are two bearing factors which should not be overlooked. One is the fallacy of fixing a permanent charge on the basis of temporary and shifting costs of operation; the other, and perhaps the more important, is a consideration of the satisfaction and convenience of patrons.

Economic writers tell us that the high cost of living is affecting not only individuals but also corporations. A street-car ride is one of the few public necessities which has not kept pace with the general upward trend of prices. Except for copper all the thousand and one supplies necessary in the construction and operation of an electric railway now cost more than they did five years ago. Rolling equipment and roadbed are not exempt from wear, and each year finds a greater depreciation than the former. Wages are also soaring. In view of climbing costs and reducing revenues, capital may hesitate to assist what appears to be a hazardous undertaking. Such hesitancy can but retard the good work which is being done by electric traction companies in developing outlying real estate.

As a matter of fact, all signs show that the nickel fare, which has come into such universal use as to be almost standard, will be raised rather than lowered. When we consider the convenience and the time saved by the electric car the present charge seems low enough. Many of the Eastern cities, particularly in New England, have already been forced to increase their fare to six cents, this action having the endorsement of legal decision. The road between Seattle and Tacoma has also increased its rate and it is not unlikely that other companies will soon do the same.

With respect to the public's opinion of Cleveland's street-car system we cannot do better than to quote from an article in a recent number of the Electric Traction Weekly of Chicago, which explains that the company, with the sanction of the city, refuses to make change for a nickel, and further that it will not issue a transfer unless an additional cent is tendered with the nickel. On cross-town lines the cash passenger must buy a transfer, while one presenting a transfer can transfer to another line free of charge.

Under the Taylor plan as at present in force in Cleveland, you can pay anywhere from three cents to twelve cents to reach your destination. Small wonder that the people are already showing dissatisfaction, when it is considered that the proposition made by the Cleveland Electric Railway two years ago offered a rate of seven tickets for twenty-five cents and free universal transfers, over the entire system.

One of three ladies who had boarded a car dropped a dime into the fare box to pay for three fares at three cents per, and she tendered two cents more and demanded three transfers at one cent per. The conductor informed her that without the change the fares would be five cents per and the transfers one cent each. The arguments those three indignant ladies put up and the threats of the conductor to eject them, tied up a line for ten minutes. The authorities decided that the conductor was in the wrong in this case.

Another woman tendered fifty cents with the expectation of getting a ride for three cents and a transfer for one cent, but found that she must first pay five cents for her fare, receiving forty-five cents in change and then pay five cents more for a transfer, receiving four in change. These examples indicate the vexatious confusion attending what should be a simple transaction.

PERSONALS.

W. G. Kerckhoff, of Los Angeles, was a visitor in San Francisco last week.

J. C. Kirkpatrick, president of the National Pole Co., is visiting San Francisco.

W. M. Carpenter, president of the American Cross-Arm Co., is in San Francisco.

F. B. Gleason, manager of the San Francisco offices of the Western Electric Co., has returned from the East.

R. S. Chapman, engineer for H. M. Byllesby & Co., recently returned to San Francisco from a trip to Los Angeles.

M. M. O'Shaughnessy is in San Diego superintending the construction of a large dam for increasing the city's water supply.

W. S. Heger, Pacific Coast manager of the Allis-Chalmers Company, has returned to his San Francisco office, after a trip to the factory in Milwaukee, Wis.

W. P. Hammon, who is at the head of the California-Nevada Power Company and of the Truckee River General Electric Company, has gone East on business.

Prof. M. E. Cooley, dean of the Engineering Department of the University of Michigan, is one of a party of college professors who are making a tour of the Pacific Coast.

Frank H. Ray, who is interested in the Rogue River Electric Light & Power Company and its subsidiary corporations in Southern Oregon, was a San Francisco visitor during the past week.

Harry C. Rice, vice-president of the General Incandescent Lamp Co., of Cleveland, who is making a tour of the Coast, arrived in San Francisco April 19th. He will visit Southern California next.

Harry Brownlee, Berkeley manager of the Pacific States Telephone & Telegraph Company, has been advanced to the managership of the San Jose district and has been succeeded by Herbert Cheek.

W. E. Adams, who is connected with the management of the Stockton Gas & Electric Company, arrived from Stockton last week and reported an excellent outlook for business in the San Joaquin Valley.

H. A. Lardner, manager of the San Francisco office of the J. G. White & Co., who has been confined to a local hospital with typhoid fever for several weeks, is convalescent and will be out in a few days.

F. W. Gray, mechanical engineer for the J. G. White & Co., and Albert S. Crane, the chief hydraulic engineer for the company, have arrived from New York and are visiting the company's San Francisco branch.

C. E. Sloan, of Spalding, Sloan & Robson, engineers, has returned from a trip to Newman, Cal., where he has been supervising a waterworks contract. E. B. Spalding, of the same firm, will remain at Newman for some time on similar business.

Beach Thompson, promoter of the Stanislaus Electric Power Company, recently visited New York City to confer with Patrick Calhoun and officers of the United Railways Investment Company of New Jersey regarding the plans for the further development of the plant near Sonora, Cal.

C. E. Groesbeck, vice-president of H. M. Byllesby & Co., of Chicago, spent several days in San Francisco and departed during the past week for Portland, Ore., where offices are now maintained in connection with the operation of a number of Pacific Coast electric power and gas plants.

Paul Shoup, formerly assistant general passenger agent of the Southern Pacific Company, has been appointed assistant general manager in charge of the electric lines. Shoup's new position gives him charge of all of the electric lines owned or controlled by the Southern Pacific Company, including the lines in Los Angeles, the Peninsular electric lines and the Alameda County lines upon their completion.

Frank R. Wheeler, Pacific Coast Manager of the C. H. Wheeler Mfg. Co., has returned from a trip to Puget Sound and British Columbia in the interest of his Company. He reports recent sales of Condensing apparatus to the Hammond Lumber Co., Spreckels Sugar Co., Pacific Fruit Express, Union Ice Co., L. A. Gas & Electric Co., and the Kleeb Lumber Co. U. S. Mint, San Francisco.

PACIFIC COAST ELECTRICAL EXPOSITION.

At a meeting of the Pacific Coast Electrical Exposition exhibitors held Friday, April 15th, it was unanimously decided to postpone the electric show until some time in September, as the proposed Auditorium was found to be too small to accommodate the exhibits. Mr. S. Naphtaly, of the City Electric, and Mr. Geo. C. Holberton, of the Pacific Gas & Electric Company, were selected as an advisory committee to act with the board. Vacancies caused by the resignation of E. M. Scribner and R. B. Elder have not as yet been filled.

Too much credit cannot be given to Mr. W. W. Briggs for his persistent and earnest work in behalf of this electrical show. And now that the General Electric Company, through its representative, Mr. T. E. Bibbins, has declared their intention to participate, the exhibitors show considerable enthusiasm, and are determined to give one of the finest electrical exhibits ever held west of Chicago. The postponement will give ample time for preparation and we hope that every Eastern manufacturer of electrical goods will realize the importance of being represented.

PORTLAND SECTION A. I. E. E.

At a meeting of the Portland Section A. I. E. E., held on April 19th, W. M. Hoen read a paper on "The Electrical Installation of a Modern Quartz Mill." Mr. Cary T. Hutchinson's paper on "The Electric System of the Great Northern Railway at Cascade Tunnel" was abstracted by Mr. Paul Lebenbaum. Mr. Lebenbaum also presented a short paper on "Heavy Traction Work" of his own experience.

SAN FRANCISCO SECTION A. I. E. E.

A meeting of the San Francisco Section A. I. E. E. will be held in the Home Telephone Company's building on April 29, 1910. A paper on the "Watthour Meter" will be read by A. G. Jones and Wm. M. Shepard.

TRADE NOTES.

Wilbur H. Jackson, 404 Sutter street, has been appointed agent for the Hoffman-Corr Manufacturing Company and carries a stock of their cotton waste and oakum.

The San Diego Consolidated Gas & Electric Company has purchased one General Electric 3-phase, 60-cycle, 32-pole, 185-kw. (250 h.p.), 225-r.p.m., 2300-v. synchronous motor, with a Mortisseur winding, to be used for driving an Ingersoll-Rand air compressor.

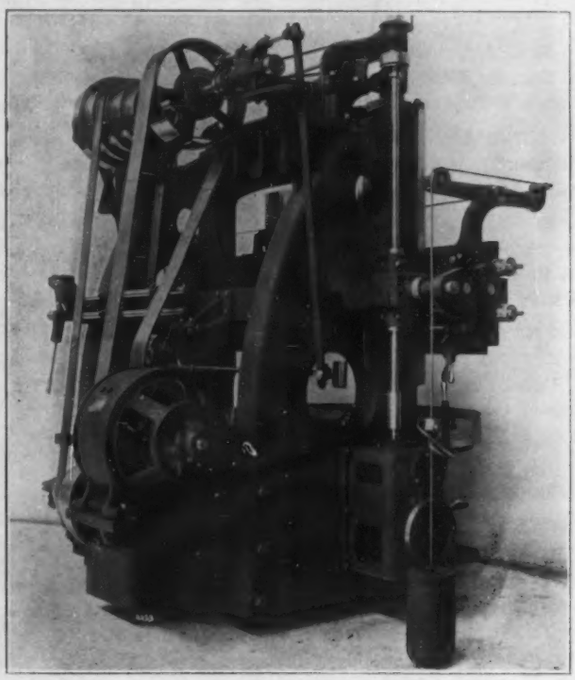
The General Electric Company has sold the following equipment to the Yuba Construction Company of Marysville, for use in a gold dredge: A 300-h. p. variable speed 440-volt main drive motor; 35-h. p. winch motor; 150-h. p. high-pressure pump motor; 25-h. p. auxiliary pump motor; 60-h. p. 4,000-v. primary—460-v. secondary transformers.

INDUSTRIAL

A NEW TYPE OF LARGE BORING MILL.

The 60-in. motor-driven boring mill shown in the accompanying illustration, is one of a new line of machine tools which embody a number of valuable improvements in design and operation. This 60-in. mill has a table 62 in. in diameter and takes work 46 in. high under the cross-rail. Its design has been figured for ample strength to withstand the heaviest cuts with high-speed steels, and has a massive angular bearing which makes the table self-centering under any condition of load or work.

The cross-rail is box-shaped, of massive proportions, and is raised by power independently of the table drive. The heads carrying the tool-holders are entirely independent in their movements, both in the direction and amount of their feed. They can be set for any angles and have a vertical or



New Type of Boring Mill.

angular travel of 30 in. Both heads can be brought to the center of the cross-rail, for boxing. The middle point is accurately marked by a positive stop.

The power rapid reverse feature is furnished regularly on all 60-in. mills. This device is entirely separate from the regular feeding mechanism, and is driven at constant speed, direct from the countershaft by silent chain. By means of frictions located at the upper ends of the vertical feed shafts, a rapid motion is communicated by power to the feeding mechanism. These frictions can be engaged instantly at any time by simply pulling the rapid traverse lever, located in a convenient position above the feed box. Pulling this lever automatically disengages the regular feed, and reverses the travel of the tool at a speed of 9½ ft. per minute horizontally, and 6 ft. per minute vertically and in angular directions. It is impossible for accidents to occur with this device, and no mental effort is required on the part of the operator, as there is but one direction in which to pull the lever, which always returns the tool over the surface on which it has taken the cut.

The power rapid traverse is one of the greatest labor-saving and production-increasing devices ever put on a boring mill. It entirely eliminates the laborious work of moving the heads by a crank-handle or a wheel.

The safety shear-pin device placed on the rear of each end of the cross-rail, prevents injury to the feed mechanism in case the heads are accidentally run together. A coupling introduced into the vertical-feed-shaft transmits its motion through a small pin, which is arranged to be sheared off in case any abnormal stress occurs in the feed mechanism. Additional pins are furnished, or in case of emergency, a wire nail may be used equally well.

This 60-in. boring mill is driven by a 10 h.p., 1180 r.p.m., Westinghouse constant-speed type S direct-current motor, belted through countershaft and cone-pulleys to the driving shaft of the mill. A belt-shifter makes the changes from step to step of the cone-pulleys easily and quickly, and without injury to the belt. The friction clutch in the cone-pulley countershaft permits the mill to be stopped and started without interfering with the motor.

The new line of large boring mills, described and illustrated in the foregoing, and which includes machines built in 42, 48, 54, 60 and 72-in. sizes, is manufactured by the Colburn Machine Tool Company, Franklin, Pa. These machines may be equipped with constant or adjustable-speed Westinghouse motors, if desired.

NATIONAL PUBLICITY FOR BENJAMIN ELECTRIC MANUFACTURING COMPANY.

The Benjamin Electric Manufacturing Company of Chicago is carrying on a campaign of national publicity for the Benjamin plug cluster in many of the popular magazines, thus supplementing its advertisements in the trade journals. The purpose is to reach the ultimate user and create a demand for a socket which doubles the fixture capacity.

NEW CATALOGUES.

The Roller-Smith Company, 203 Broadway, New York City, have issued an attractive catalogue on its electric automobile type ammeters and voltmeters. Their distinguishing features are resilient mounting and zero adjustment.

The Western Electric Company has recently issued its bulletin No. 5132-1, describing its type EC belt-driven Hawthorn generators. A complete description of the construction and operation of its generators is given, with illustrations of the different types. Considerable space is given to a description of the individual parts of these generators. Copy of the bulletin will be sent upon request.

A subject apropos of the season is taken up in the General Electric Company's Bulletin No. 4719, describing its fan motors and small power motors for the season of 1910. This publication illustrates and describes fans suitable for use in the home, office, or public building, for installation on a desk, table, wall, floor or ceiling, and for use in telephone booths. It lists also fans for ventilating purposes, and illustrates small power motors for both domestic and commercial use.

In Bulletin No. 4716, published by the General Electric Company, are described several types of prepayment watthour meters, which form a practical solution of the problem of producing a satisfactory prepayment meter having a minimum number of complicated parts, and sufficiently strong to withstand the rough treatment incident to transportation and commercial use. These meters are arranged for use with either a separate or combined prepayment device. They are made for two and three-wire service, and 100 to 120, or 200 to 240 volts, direct or alternating current. This publication contains dimension of the meters, and diagrams of connection.

NEWS NOTES

INCORPORATIONS.

BORING, ORE.—The Boring Mutual Telephone Company has been incorporated for $5,000, by J. W. Roots et al.

MACLEAY, ORE.—The Lewisburg Mutual Telephone Company has been incorporated for $1,173, by Ernest Bowen et al.

BOYDS, WASH.—The Kettle River Power & Irrigation Company has been incorporated for $6,000, by Grant A. Stewart et al.

MILES CITY, MONT.—The Miles City Automatic Telephone Company has been incorporated for $300,000, by H. Hauson et al.

MOUNT ANGEL, ORE.—The Mount Angel Telephone Company has been incorporated, by C. R. Hougham, H. Klinger and G. D. Ebner, with a capital stock of $5,000.

SACRAMENTO, CAL.—Elmhurst Street Railway Company has been incorporated, with a capital of $100,000, by H. J. Goethe, H. A. McClelland, C. M. Goethe and G. P. Beere.

SAN FRANCISCO, CAL.—The Sierra Nevada Power and Irrigation Company has been incorporated, with a capital of $200,000, by J. F. Sheehan Jr., J. J. Dailey and Isaac Kermel.

SPOKANE, WASH.—The Citizens' Electric and Manufacturing Company has been incorporated, by M. J. Gardner, J. H. Peet, A. E. Anderson and others, with a capital stock of $50,000.

STEWART, B. C.—The Stewart-Portland Canal Power, Light & Water Company, Ltd., has been incorporated with a capital stock of $250,000 to supply this place and others with gas, power and water.

FINANCIAL.

ST. HELENS, ORE.—St. Helens has voted for a $50,000 bond issue for the construction of a municipal water system.

FALLS CITY, ORE.—An election decided in favor of a $20,000 bond issue for the construction of a water system, the water to be taken from a spring 2½ miles south of the town, and to be brought in by gravity.

PORTLAND, ORE.—One million dollars' worth of water bonds, running 25 years, drawing interest at the rate of 4 per cent, payable semi-annually, have been ordered advertised for sale by the City Auditor, A. L. Barbur, the proceeds to furnish money for the construction of a second pipe-line to Bull Run River.

SAN FRANCISCO, CAL.—Following is a statement of the earnings and expenses of the Pacific Gas & Electric Company, including the figures of all of its subsidiary corporations for 1909: Gross revenue, $13,650,075.28; deduct revenue in suspended (S. F. rate cases), $317,574.25; gross revenue, $13,332,501.03. Operating expense, maintenance, tax and reserves for uncollectable accounts, casualties, etc., $7,531,575.89; net revenue, $5,800,925.14. Interest, $2,988,-521.70; balance, $2,812,403.44. Deductions—Accrued dividends on preferred stock, $600,000.00; sinking funds, $667,-209.56; am. of bd. dist. and exp., $42,236.95; total, $1,309,-446.51. Balance, $1,502,956.93. The gross revenue of the Pacific Gas and Electric Company for the year 1908 was $12,853,817. The net income available for interest on the debenture mortgage bonds was $2,052,329.64. After deducting from this amount $240,000 as the annual interest on the entire authorized issue of debenture mortgage bonds the balance December 31, 1908, was $1,812,329.64. On March 31, 1909, the company's entire outstanding bonded debt in the hands of the public was $56,182,000. This was made up of: Divisional and underlying bonds, $43,378,000; P. G. & E. Co. general and collateral trust 5-per cent bonds, $9,153,000, and debenture mortgage 6-per cent sinking fund 30-year gold bonds, $3,651,000. The debenture mortgage bonds precede the following securities of the P. G. & E. Co.: $9,979,000 6-per cent cumulative preferred stock; $12,566,000 common stock outstanding March 31, 1909, of which the market value at that time was $14,500,000. The balance of $1,502,956, December 31, 1909, would show about 10 per cent on $15,000,000.

TRANSMISSION.

BUHL, IDAHO.—The Clear Lake Orchard Company will install a power plant of sufficient capacity to furnish heat and power for the Twin Falls and the North Side tracts.

JUNEAU, ALASKA.—Otto Lonstorf, general manager of the Lon De Van Mining Company, announces that a power plant is soon to be installed at the mines on George's Inlet.

MONROE, WASH.—The Snoqualmie Power Company will shortly begin work on the erection of a transformer station in Park place, where its wires cross the county road.

KOOSKIA, IDAHO.—It is reported that a Chicago company, headed by a Mr. Day, of the Marshall-Fields Company, will in the near future install a power plant on the Middle Fork.

CHEHALIS, WASH.—The Twin City Light & Traction Company let the contract for erecting a $75,000 powerhouse on its mill site in the north end of town to the Coal Creek Lumber Company.

PORT ANGELES, WASH.—The power and light franchise granted to Thos. T. Aldwell has been assigned to the Olympic Power & Electric Company, which will begin work immediately on the development of power on the Elwha River.

DAWSON, ALASKA.—The North Fork Power Company will begin within a few days to haul supplies from Dawson to the North Fork of the Klondike, where extensive development will commence. Seven and one-half miles of ditch will be built. Chas. Boiye, resident manager of the Canadian Klondike Company, is in charge of the work.

LEWISTON, IDAHO.—Local capitalists interested in the concern announce that the Lewiston-Clarkston Improvement Company, which recently passed into the control of Spencer-Trask of New York, has been bonded for $800,000 and that a large amount of money will be expended in developing a 50,000-hp. plant on the Grand Ronde River.

SEATTLE, WASH.—As a formal step in the plan of the Stone & Webster interests to develop the White River hydro-electric power enterprise, a meeting of stockholders of the Pacific Coast Power Company will be held in Seattle to increase the capital stock from $7,000,000 to $10,500,000. According to attorneys for the company, the meeting will be the last step necessary in placing the affairs of the corporation in shape to develop the White River power project, by which the waters of the river, impounded in Lake Tapps, will be harnessed and 30,000 electric hp. developed for electric and interurban railroad systems and manufacturing purposes in Seattle, Tacoma, Bellingham and Everett. The initial development at Lake Tapps will require an expenditure of about $2,250,000 and the work will be done by the Stone & Webster Engineering Corporation.

TRANSPORTATION.

LONG BEACH, CAL.—It has been stated that the Pacific Electric would build its Seventh-street extension in the early summer.

ALBANY, ORE.—The survey work has been started for the Albany and Interurban Railway, to run from this place to Sweet Home.

WALLA WALLA, WASH.—A survey is being made by the Byllesby interests for an electric line between this place and Pendleton, Ore.

KALISPELL, MONT.—A franchise has been granted to the Whitefish & Polson Electric Railway Company for its railway system here.

WHITEFISH, MONT.—This place has granted a franchise to the Whitefish-Polson Electric Railway to construct its road through town.

CITY OF MEXICO, MEX.—A street-car line is being planned to connect Merida with the ruins of Uxmal. This will be a great convenience to tourists.

SNOHOMISH, WASH.—The City Council has granted a 25-year franchise to the Seattle, Snohomish & Everett Railway Company to build lines within the city.

PORTLAND, ORE.—Geo. D. French, president of the Spokane, Portland and Seattle Railroad, states that equipment and improvements for the road will entail an expenditure of $1,500,000.

SALT LAKE CITY, UTAH.—Le Grand Young has received a franchise from the Board of County Commissioners for his proposed electric railroad to connect the Emigration Canyon road with Holliday.

STOCKTON, CAL.—It is probable that the Central California Traction Company, now operating an electric line to Lodi and building to Sacramento, will also construct a line to Lockeford, which is northeast of Stockton about 12 miles.

EUGENE, ORE.—It is announced that the Portland, Eugene and Eastern Railway Company has secured financial backing for its proposed system of electric roads to be constructed in this vicinity. A. Welch is general manager of the company.

PORTLAND, ORE.—A contract has been let to the Porter Bros. for the construction of the Cornelius Gap tunnel of the United Railways, and machinery is now being rushed to the scene of operations, with a view to having the big underground passage completed before the end of summer.

EVERETT, WASH.—A $5,000,000 mortgage in favor of the Chicago Title & Trust Company, and signed by O. E. Crossman, president, and Charles H. Barron, for the Everett-Tacoma Railway Company, which proposes to build an electric road to Tacoma via Snohomish, Monroe, Tolt, Renton, Kent and Puyallup.

RIVERSIDE, CAL.—Application has been made to the Supervisors for a franchise for a trolley line for connecting the towns of Moreno, Lakeview, San Jacinto, Hemet and Florida and extending up to foot of grade in San Jacinto Mountains. The proposed road is 25 miles long. J. B. Jackson, who has interests in the San Joaquin Valley, made the application. The board favors the proposition.

MODESTO, CAL.—The Modesto interurban terminal will be on South Eleventh street, between D and F. The company has purchased the half-block on Eleventh street, across from the Kewin stables, taking in the Harris machine shop, and the half-block south, between D and E streets. It is understood that the company will build a passenger depot on the site, together with freight sheds and other buildings to accommodate the traffic. It is expected that announcement of the running schedule of the new line will be made within the next few weeks.

OAKLAND, CAL.—Grading work for the extension of the tracks of the Southern Pacific from the present terminus in Melrose, along the foothills eastward to Stonehurst, where a junction will be made with track already laid, thereby completing a loop suburban system which will extend almost completely around the newly annexed districts of Oakland, has been commenced on the north side of Melrose by Peter Hare, a Hayward contractor. The Southern Pacific already has a spur track running from its main line which taps the southern side of the annexed district, to Stonehurst Station on East Fourteenth street. The grading work commenced will be for the extension of the tracks which now reach Melrose Station. The tracks will extend across East Fourteenth street toward the foothills and then turn eastward as far as Stonehurst. It is probable that the loop system may also be extended as far eastward as San Leandro, the running schedule being arranged so that only several trains a day shall run through that town, while the majority of them shall go over the other loop system which goes through Stonehurst. The preliminary grading work commenced is in the vicinity of the Scenic or Foothill boulevard.

ALAMEDA, CAL.—Mayor W. H. Noy has received word from the Southern Pacific Company that its new Alameda electric train service would not be ready for operation before September 1st. The company has ordered 125 standard electric cars for its Alameda County lines. Of this number 40 are motor cars, 25 are combination motor cars and baggage coaches, and 60 are trailers. The cars are 58 feet long and are being built in the shops of the American Car and Foundry Company, at St. Charles, Mo. The Baldwin Locomotive Works is furnishing the trucks, and the motors will be supplied by the General Electric Company. The Southern Pacific track-layers have commenced work on the new cross line, which is to run between Alameda and Oakland and be one of the features of the new electric service of the company. This line is being built upon Eighth street in West Alameda, and will connect on the north with the present line across the Alameda marsh. A connecting link will be built near the water front to straighten the line to the Alice-street bridge. Electric trains will then be able to run direct into the heart of Oakland, stopping at the present Oakland narrow-gauge terminus and Fourteenth and Franklin streets, or possibly continuing out into Berkeley over the projected extension. This line will make the Southern Pacific an active competitor of the Oakland Traction Company for the Alameda-Oakland service. A 5-cent fare will be charged and transfers from the regular Alameda loop system will be given without additional charge.

ILLUMINATION.

EL PASO, TEX.—Six or seven miles of mains will be laid soon by the El Paso Gas & Electric Company.

MEDFORD, ORE.—The Council passed an ordinance granting to J. R. Anderson the right to lay gas pipes and conduits for a period of 35 years in the public streets and alleys of the city of Medford.

SALINAS, CAL.—Sealed bids will be received by the Clerk of the Board of Supervisors up to 2 p. m. May 4, 1910, for the construction of an electric light system at the County Hospital of the county of Monterey, Cal.

KINGMAN, ARIZ.—The capacity of the electric power plant at this place of the Tracy Engineering Company in the Central building, will be increased by the installation of more machinery at the cost of about $30,000.

CHICO, CAL.—The announcement is made that the Sacramento Valley Power Company will be actually competing for business in this city by April 20th. The transformers are now being installed, and the line between Redding and Chico has been completed. Nearly 1,000 poles have been planted in Chico, and most of the wires have been strung.

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